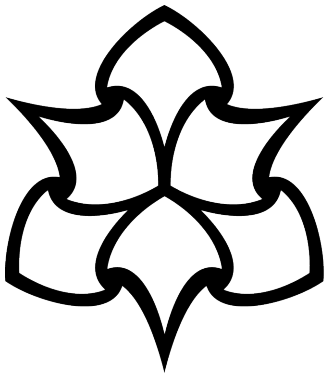

Pattern making

for new fabric joining technologies

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MA (by Research)

2018

PATTERN MAKING FOR NEW FABRIC JOINING TECHNOLOGIES

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Abstract

Abstract

Fabric joining methods of welding and bonding can bring new possibilities to garment design and construction, offering a number of benefits over traditional sewing. Current applications are mostly limited to sports apparel, performance wear and lingerie, due to the functional benefits that they can bring to garments. These technologies have unexploited potential in fashion clothing and offer benefits to the manufacturing process by simplifying many traditional cut and sew construction methods and reducing seam components. The process of developing garments with these new technologies, however first requires a fundamental understanding of their technical capabilities. The research examines how a design practice-based enquiry can be used to develop and adapt approaches to pattern making that consider new fabric joining technologies. Taking inspiration from historical pattern cutting approaches and strategies for design, allows for a consideration of the production methods and technology throughout the design process. The practice output of this investigation is a series of contemporary women's wear pieces that evidence the development of a pattern making approach that incorporates welding and bonded constructions to offer new design possibilities and consider manufacturing efficiencies. The study highlights the need for a holistic design approach that considers the technical capabilities and constraints of the joining technologies.

Contents

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I would like to thank Dr Kathryn Brownbridge for her kindness and clear guidance.

My biggest thank you goes to my ‘team’ for encouraging me every step of the way, my wonderfully supportive husband and my beautiful babies x

Background

Background to study

My own interest in fashion came from making clothes as a young teenager and through studying a fashion design degree where I was introduced to flat pattern cutting methods as a means of realising design sketches. As I already had considerable knowledge around sewing, garment construction and fitting clothes I found myself inspired by the more technical aspects of fashion design. Rather than sketching out my designs then working out how I could make the pattern, I started to develop ideas by thinking about the patterns first. Through researching Madeleine Vionnet, I learnt how she used her technical knowledge gained as an apprentice in an atelier, to develop the creative ideas in her work, draping fabric on a miniature mannequin to formulate her ideas (Van Godtsenhoven, 2016). See figure 1 (Milenovich, 2007:58)

*Figure 1:*Madeleine Vionnet draping in 1934 (Source: Milenovich,S. 2013: p58)

When I began to develop ideas for my final degree project, I followed this same practice, using small sections of cloth, draping and pinning them on a small mannequin, and then using these to inspire and develop my design ideas. (See fig.2 (Etheridge,E. 2002))

Figure 2-Draping on half scale model (Source: Etheridge,E. 2002)

Vionnet approached the silhouette and the body in a very different way to her contemporaries. Her interest in the Japanese kimono, influenced her to abandon '… the traditional practice of tailoring body-fitted fashion from numerous complex pattern pieces, and minimize the cutting of fabric' (Mears, 2008:105).

As I began my own research into the kimono, I learnt of the simple geometric pattern pieces, which make up its construction and how the component pieces are placed strategically on the cloth to leave no fabric waste. See figure 3 showing cloth layout and construction of a kimono (Milenovich, 2007:21)

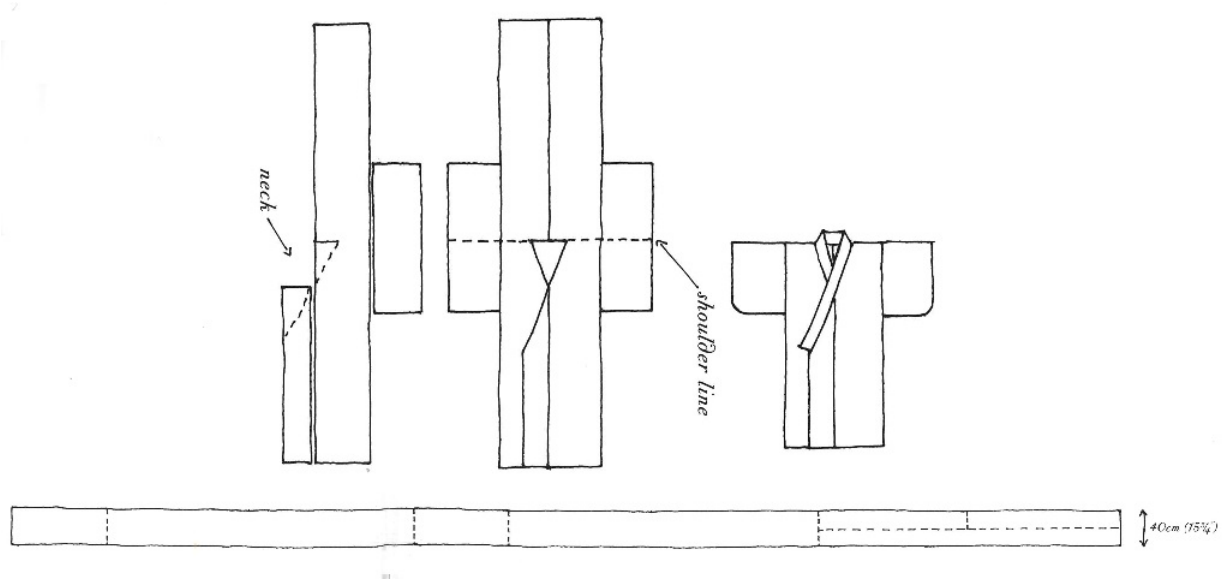


Figure 3: Japanese kimono construction with indication of fabric layout (Source: Milenovich, S. 2007:p21)

The garments I designed for my final degree collection followed principles inspired by Vionnet. The designs were developed through draping in miniature, I used geometric forms as the basis for the garments shapes and I focused on simplifying the patterns and construction. (See fig.4 & 5 (Etheridge,E. 2002))

Figure 4-Degree Collection sketchbook development work (Source: Etheridge,E. 2002)

Figure 5-Final degree collection at Graduate Fashion Week (Source: Etheridge, E. June 2002)

Later when working as a designer / maker, I explored the same approach to garments in my work, using the process of draping to inform my designs and to simplify the form of the patterns and the construction techniques. I was able to continue to explore this as a design methodology once I began teaching on a degree course. As a way of encouraging students to focus on silhouette, I taught a method of using simple geometric shapes as a starting point for the generation of design ideas. See figure.6 (Etheridge,E. 2002). I encouraged them to work on a small scale in 3D, to explore design possibilities and simplify patterns.

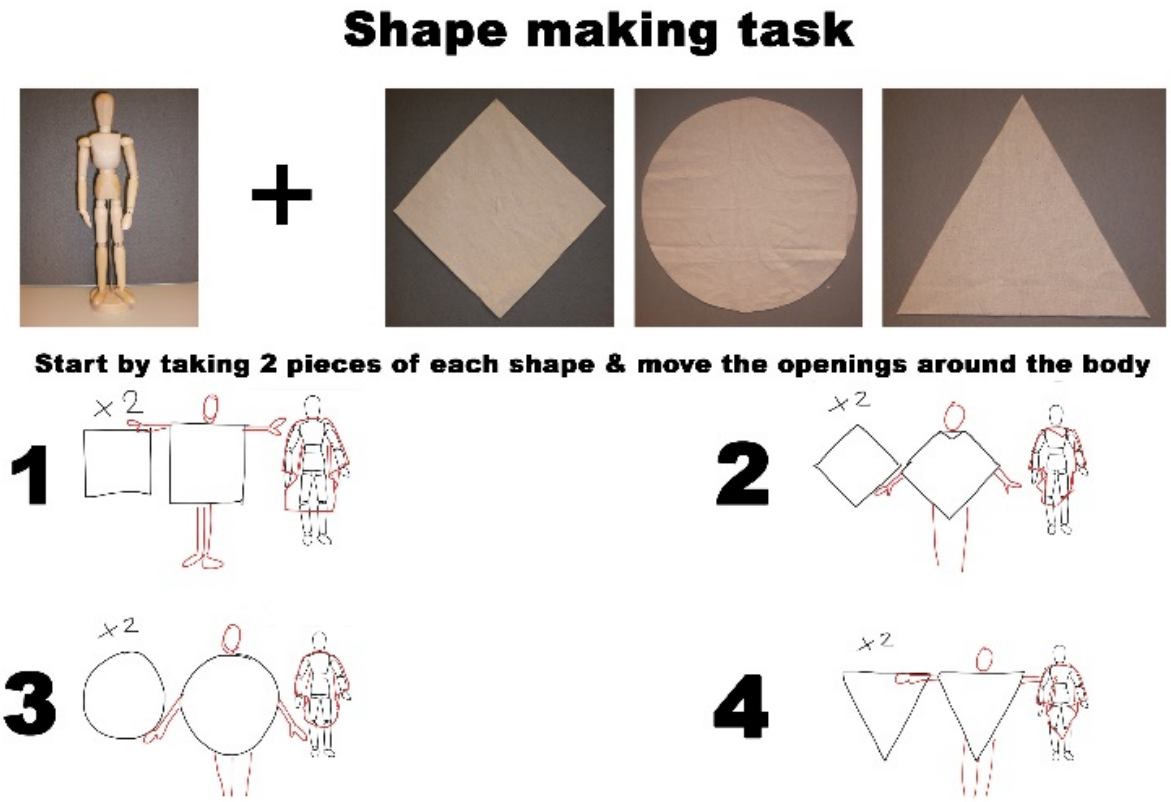


Figure 6: Fashion degree shape making task (Source: Etheridge, E. 2008)

When I joined a new department within the University, I was introduced to machinery that allows fabric to be joined through non-sewing methods of welding and bonding. Some initial research revealed the benefits that these methods could offer as a new construction technology and some potential technological advantages that they could offer over sewing. It was clear to see at this point that welding and bonding could offer construction methods not possible with sewing, I was curious to see if this could also open up new ways of designing patterns.

As my personal approach to generating design ideas is through the exploration of pattern ideas, I considered that this might be a suitable way to incorporate a new construction technology into garments. If I could design garments 3-dimensionally, developing pattern ideas as I learnt about the new construction methods, I speculated that this process would allow me to adapt the design of the pattern and the garment to suit the particular joining method. As opposed to drawing a sketch and then interpreting it into a pattern, if I could integrate the garment's design and construction processes then I could engineer the designs and patterns towards the capabilities of the joining methods.

It was clear that welding and bonding could offer many technical advantages over sewing in clothing, as well as opening up new design and aesthetic possibilities. As initial research had shown that current use is restricted to few clothing markets, this pointed towards unexploited potential. However, in order to explore these possibilities, it also important to consider the wider reaching implications of introducing a new construction technology to clothing manufacturing.

Introduction

Introduction

Throughout this paper, the terms fabric joining technologies and joining technologies will be used to refer to alternative means of joining textiles other than sewing. These will be further defined within the text to indicate the particular methods that are the focus of this study.

The thesis documents a practice-based enquiry examining how design approaches can be developed to consider how new fabric joining technologies can be incorporated into contemporary fashion garments.

From the perspective of a designer / maker, the research examines how the process of pattern making can be used to develop design ideas, whilst taking into consideration the technical constraints of the fabric joining technologies of bonding and welding.

Advancements in textiles have necessitated an evolution of joining methods that imitate the characteristics of the cloth. Welding involves a process of applying heat and pressure to a synthetic fabric to form a join and bonding utilises a heat-activated adhesive applied again with heat and pressure. Such methods offer a number of benefits over sewn seams such as waterproofing, sealing, reduced weight and bulk as well as offering a clean aesthetic appearance and eliminating thread. Applications of these joining technologies in apparel are currently limited to markets where their functional benefits can be exploited specifically performance apparel, sportswear and lingerie. Despite the advantages that these new fabric joining technologies present over sewing methods in garments, they are not used widely used outside these markets. As this study focuses on their use in contemporary fashion clothing, it is important to specify that incidences of the use of welding and bonding as a construction method in this market are few. As a relatively new and specialist construction method, there is limited knowledge around the technology and a very limited amount of literature relating to them.

Machinery and seam types differ greatly from traditional sewing methods and therefore require specific technical training, skills and expertise. To fully exploit the potential of these new joining technologies, new approaches to garment construction are needed, the following sets out the scope of this study.

Aim: To examine how a design practice-based enquiry can be used to develop and adapt approaches to pattern making that consider new joining fabric technologies for contemporary fashion.

Objectives:

1. To identify new joining technologies and test their application within the design and development of fashion garments.
2. To critically review literature relating to methods of shape generation that can inform an original 3D design methodology for new fabric joining technologies.
3. To apply an experimental holistic approach to the design and development of fashion garments that considers the technical requirements of fabric joining technologies.
4. To evaluate the outcomes of the practice using feedback from industry experts.

As literature on joining technologies is limited, library searches will allow for identification of material to highlight specific issues to consider in the practice. Web searches will provide visual material, which demonstrates applications in clothing to inform practical testing and the design development of garments. Underpinned by this research, the next stage of the literature review will be used to select an approach to shape generation that considers the constraints of the joining methods. This focused review related to pattern cutting practices, will be undertaken in order to inform the design methodology and provide visual material for analysis.

Practice is central to the study and is the means by which garment designs will be developed. Practical sampling of welded and bonded seams will act as a testing stage in order to select the most appropriate methods for garment construction. This process will also inform the design and development of the garments, as the technical constraints of the selected methods can be considered in their design. Using an approach to shape generation informed by the capabilities of the joining technologies and adapted from methods provided through the literature, creative

design solutions can be generated using the pattern making process as a means of design. Reflection will be used as a tool throughout the practice, and knowledge acquired through this process will be applied to the practice to inform and develop appropriate design strategies. The resulting practice demonstrates how the knowledge gained from the research study has been applied to a range of contemporary fashion garments, which incorporate new fabric joining technologies.

Key industry figures with expertise related to the field of study will provide feedback on the outcomes of the practice. This feedback will allow for the results of the practice to be evaluated against the aims of the study to consider whether it offers appropriate solutions relevant to the research question.

Literature Review

Chapter 1 Literature review

1.1 Outline of literature review

The literature review is themed into two main strands. The first part details the fabric joining technologies and considers the issues surrounding their application in clothing. This stage provides the foundation for the second part of the review, which seeks to identify appropriate methods of shape generation, which consider the constraints of the construction methods. This review will inform the strategy used in the subsequent stages of the practice and provide justifications for the development of the design methodology to provide the project outcomes. This literature review therefore establishes key themes and terminology and seeks to identify the crucial factors to consider in the practice.

1.2 Joining technologies

1.2.1 Introduction & definitions of joining technologies.

Currently, the most common method of joining the component parts of garments is by sewing or stitching with needle and thread (Petrie, 2015). Alternative means of joining fabrics have developed over a number of years; these methods have become more popular in clothing production due to a number of benefits that they can offer over traditional stitching. In addition to eliminating thread, seams are lower profile and lighter weight, offering waterproofing and seam sealing properties as well a cleaner aesthetic appearance. In terms of construction, some more complicated garment processes can be simplified using joining technologies offering a cost reduction through labour saving.

New joining technologies can be classified into two distinct classes of machinery depending on the methods used to create the seam: welding and bonding. Welding uses heat to melt the synthetic fibres in a fabric at the required area, forming the join once cooled. This process is restricted to fabric made from a high percentage of thermoplastic fibres such as polyester, nylon, polyester, acrylic and polypropylene. Examples of welding methods include ultrasonic welding, RF or high frequency welding, hot wedge, hot air and laser welding (Jones and Wise, 2005). In order to detail welding processes, machinery and applications, any

content related this has been analysed and summarised in tables, which can be found in Appendix 1 on pages 1-10. Bonding methods use an adhesive material at the interface between the points to be joined. A heat-activated solvent or adhesive component is then applied between the surfaces to be bonded and the bonding machine applies heat to the adhesive to facilitate the join. Fabrics required for bonding are not restricted to synthetic fibres, thus bringing greater versatility, although bond strength varies with the textile design, fibre property, density of the cloth and seam design (Jones and Wise, 2005). Appendix 2 pages 11-22 details the bonding machinery used for the study, as examples of some typical processes. The literature has been analysed and summarised into tables to provide some definitions and typical applications.

1.2.2 Welded and bonded seaming technology.

Research in the area of joining technologies has mainly focused on the functional qualities of seam formations with many studies assessing the function of the seams and producing data to measure their effectiveness. The majority of research pertaining to the different methods of joining technology do not relate specifically to their use in clothing, but rather textiles in general, however they do provide a number of critical results for consideration.

Research which considers the efficacy of joining methods in seams has been the focus of some studies with the earliest example Reddy (2007) focusing on ultrasonic seams in polyethylene terephthalate (PET), PET/Cotton Blend, and Spectra fabrics. Welded ultrasonic seams of various designs were produced with varying weld times and pressure, in two different modes of operation: plunge and continuous. Plunge mode secures the fabric in the machine in a fixed position and the ultrasonic energy is applied to create the weld. Continuous mode pulls the fabric through the machine via a rotating disc or anvil and the weld is created at the point of contact between the machine's plate and the anvil. These samples were compared to sewn seams in the same range of fabrics and were assessed. Conclusions indicated that a compromise may be necessary between seam stiffness and strength, although adhesive tapes would allow for increased strength without extra stiffness. A later study by Ghosh and Reddy (2009) built on this earlier research, looking again at ultrasonic seams and focusing on polyester and Spectra fabrics. Seams were produced in plunge and continuous mode and time and

pressure were varied across seam samples. Considerations in terms of seam strength were compared against sewn seams and as with the previous studies described, the parameters required very careful control to avoid heat damage to the textile and to achieve a satisfactory join. Promising aspects offered by ultrasonic welding, which requires no other components for the seam are highlighted in the study along with the cost reduction potential of the method, the opportunities for recyclability and the possibility of seam sealing with certain seam designs. However, as results also point to poor seam strength with ultrasonic welding it may not be appropriate for seam construction in garments, which need to withstand the stresses of wearing. Although this suggests that ultrasonic may not offer seam strength appropriate for garment construction, it may offer suitable alternatives for other parts of the garment without the same requirements.

Research which looks specifically at the use of joining technologies in clothing includes Jana (2011) who provides an overview of their use in functional garments. The research reports the characteristics and developments of joining technologies, highlighting that the benefits that they can bring to functional garments i.e. the reduction of bulk and weight in seams, the cleaner appearance and the seam sealing properties have increased their popularity for use in clothing. Challenges were also noted and this included difficulties in the joining of deep curves and the production of flexible and stretch seams for welded applications.

Two studies, which are the most relevant to this research are Seram and Cabon (2013) and Seram and Cabon (2014). The first investigates the possibilities of using ultrasonic welding in clothing and the second looks at the application of ultrasonic welding in contemporary women's fashion; proposing this as an alternative method of construction in clothing. Significantly, for this research, both studies highlight the issues that may be presented when applying ultrasonic welded construction methods to clothing production. The advantages proposed over stitching are: the elimination of thread and no thread matching or seam deterioration. In order to apply ultrasonic welding methods to garments in the study, Seram and Cabon (2014) used technical knowledge of the machinery to underpin the design development, pattern cutting, selection of fabric and construction techniques. Crucial insights provided by both these studies are the need for mastery of the machinery to ensure accuracy and to inform the design and

construction of the garment to suit the joining method. This suggests that developing technical knowledge related to the capabilities of the joining technology is a critical step in determining the design approach to take to the garment and highlights the need for practical machine testing. Both these studies however, echo Reddy (2007) and Ghosh and Reddy (2009) in reporting poor seam strength with ultrasonic welding and suggesting the addition of tapes would improve this, although the study did not test these alternatives in the garments.

Seram and Nandasiri (2015) investigated the construction of bonded seams in comparison to sewn seams in terms of strength. Results indicate superior seam strength in the bonded samples compared to the stitched seams. The authors indicate that the industry must consider the advantages of high seam strength and low profile comfort to the wearer along with the high cost, inconvenience and practicalities of implementing new manufacturing methods if bonding is to be more widely adopted in clothing manufacturing.

1.2.3 Trade reviews and marketing claims.

Interest in joining technologies as an alternative to stitched seams, for use in clothing has been the subject of a number of articles in trade journals aimed at the textiles, textile manufacturing and apparel sectors since 2003. In order to systematically identify any potential benefits of using new fabric joining technologies, articles reviewing the technology in trade journals were scrutinised and the benefits and challenges were noted.

Perhaps to coincide with the launch of their new product lines, Bemis a manufacturer of thermo-plastic adhesives, tapes and films for bonding solutions in apparel, feature in a number of articles; *Sporting Goods Business (2003)* and (2004) *Textile World* (2004) and *Fabriclink* (2004). The article lists: cost reduction, labour saving, simplification of garment construction techniques and a reduction in the number of machine operations in garment production as additional benefits of using bonding technology. Rodie (2004) and *Sporting Goods Business* (2004) describe how bonding methods present some distinct advantages over welding; curves in seams are possible, they have good stretch and recovery and superior strength.

The studies, described in section 1.3.2 predicted that some of the barriers to adoption of joining technologies within the industry would be related to technical training, development and support. Addressing this issue, Bemis expanded their markets from lingerie, into the outerwear sector by working hand in hand with the brands and their designers to modify their products to suit their particular end use (Rodie, 2004). The company also work with their customers throughout the product development process, providing global technical support and advice on the optimum bonding conditions required for each application (SportingGoodsBusiness, 2004). Framis Italia, a manufacturer of adhesive tapes and films, perhaps in acknowledgement of the need for technical support for such new construction methods, also supply the machinery for application of their products enabling them to provide comprehensive technical expertise to their customers (WSA, 2006).

1.2.4 Issues around the application of fabric joining technologies.

Is it clear through examination of the literature, why there is currently limited adoption of fabric joining technologies across the clothing industry. Although they offer a variety of advantages over traditional stitching in clothing, the use of joining technologies in production presents specific issues related to their technical requirements. As developing products and manufacturing with these construction methods requires specialist skills and knowledge, this would need significant investment from brands and manufacturers. Despite their limited appeal and cost implications however, a number of more recent articles in *Stitch World* (2014), (2017c), (2017b) and (2017a) confirm that their use for clothing manufacturing has increased in recent times.

Through the process of the literature review, it is important to identify the factors to consider to successfully implement fabric joining technologies into clothing and allow these to inform the practice in the study. A most significant factor, highlighted by Seram and Cabon's (2014) study was how technical knowhow informs the design process. Literature identified through trade journals emphasised the same point, stating that there is a need to re-think traditional cut and sew methods (Rodie, 2004), suggesting that existing clothing manufacturing methods need to be adapted as 'The entire product has to be holistically redesigned, redeveloped and reengineered.' (Zoll, 2008:20). Further explanation is not offered through the

literature, to suggest how changes have been made to design, manufacturing or training to address how these adaptations can be implemented. Brands who have successfully incorporated joining technologies into their garments, however have done so by inventing new ways of working (Swantko, 2004) although such methods are not explicitly stated in the literature. Outerwear companies such as Helly Hansen (Gural et al., 2012), Arc'Teryx and Mountain Hardwear have devised new construction techniques with joining technologies, specifically for their products, but again, no descriptions are provided as to what impact this has had on other elements of the garment development process.

In order to allow the technical capabilities of the joining technologies to provide a foundation for the design of garments, therefore this suggests that it is necessary to consider how every aspect of the garment's design can be adapted to account for this.

Testing with the machinery will provide a broader technical understanding of the joining methods for the practice at the next stage of the research, although many key insights have been provided for this process by the literature review. The issues of poor seam strength and problems with curved seams in welding as well as the need for very specific machine parameters offer findings that can be tested and confirmed through testing. Equally, the superior seam strength offered by bonding methods will be another important issue to test. Considering the need for a holistic design approach, another factor would be to select garment and patterns shapes appropriate for the capabilities of the joining technologies.

1.3 Shape generation for fabric joining technologies.

1.3.1 Introduction

The first part of the literature review focused on identifying fabric joining technologies and revealed some of the key factors to consider when applying them to the design and development of garments. This section of the literature review builds on the insights provided by the previous section related to the need for a holistic design approach. Material provided through this process will allow for selection of an appropriate approach to shape generation that considers the capabilities of the joining technologies. As the insights presented by the first part

of the literature review stressed the need for a clear understanding of the technical constraints of the construction technology, these considerations will be used to take a focused approach to reviewing the literature. The constraints of the construction technology will be used to inform the design approach to take to produce the final outcomes of the study. Therefore, the joining technologies will dictate how the shape of the garment will be created.

1.3.2 Considerations for selection of an appropriate shape approach.

Literature related to the technical constraints of using joining technologies for garments revealed that although some welding methods may not offer suitable seam strengths, bonding can offer seam strengths superior to stitching and therefore potentially suitable for garment construction. Literature reviewed to provide an overview of bonding machines and applications provided in Appendix 2 pages 11-22 revealed a prevalence of methods and machines suited to the use of tapes for seam applications. Considering how seams which use straight tapes could be applied to garments, it would be consistent therefore to produce garments with straight seam constructions. The main consideration when selecting shape approaches to inform research into pattern and garments designs which incorporate bonded seams therefore, would be to select garment shapes which feature straight seams.

1.3.3 The influence of technology on garment shape creation.

Initially, a review of literature related to approaches to garment shape creation used throughout the history of clothing was undertaken in an attempt to reveal a number of pattern making methods for further exploration. Appendix 3 on pages 23-31 details the process of narrowing this broad review to a suitable focus, to comply with the findings from section 1.2 on joining technologies with reference to garment shape making. The following diagram Figure 7 (Etheridge,E. 2018) illustrates the process used to narrow these initial findings to focus the literature to more appropriate methods of shape generation for joining technologies.

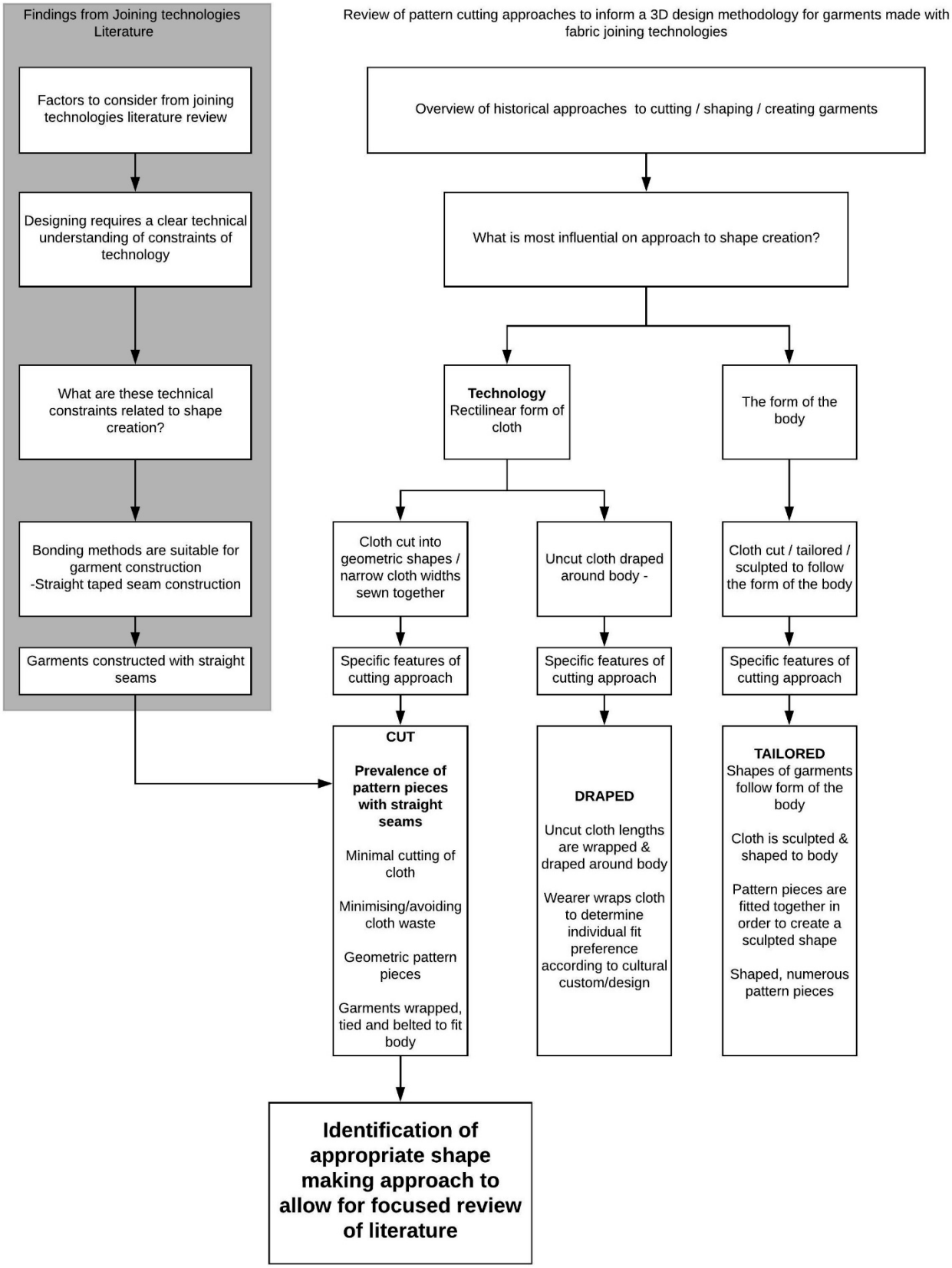


Figure 7- Process used to narrow literature review for methods of shape generation for joining technologies.(Source Etheridge, E.2018)

Once the literature review took a more focused approach and looking to garments, which use straight seams in their construction, research was undertaken into the shape approach of the Japanese kimono. The shape of a typical kimono is formed using a series of rectangular and triangular pattern pieces to incorporate a number of straight seams in the construction (Milenovich, 2007). The manner in which the shape of the kimono is cut and created derives from the rectangular form of the narrow cloth from which it is made (Sorber, 2003). A search for further literature related to the construction of the Japanese kimono revealed that costume and textiles historian Burnham (1973) also shares this view around the cutting practices related to the width of the cloth. The theory which underpins *Cut My Cote* (Burnham, 1973) is that when looking for possible reasons for the shape and form of garments throughout history, the material from which they are made has the most influence. She states that the cuts of a number of garments across different cultures are derived from the 'rectilinear form of loom-woven cloth.'(Burnham, 1973:2) The suggestion therefore, is that the form of the cloth from which a garment is constructed, directly influences how its shape is generated. Applying this logic, customary narrow Japanese cloth widths need to be joined together to fit the width of the body, so the construction is approached in such a way as to accommodate the constraints of the cloth. The author Mary S. Parker (2003), whose background is in sewing reproductions of historical garments, supports the view that cutting practices derive from cloth width. She provides an example of this in the traditional narrow West African cloth widths, which are first joined together before being wrapped around the body. Burnham (1973) additionally notes that where the cloth widths are traditionally much wider, such as in Mediterranean regions, the approach to the shape creation differs as the cloth does not present the same restrictions. Garments are made by simply draping the cloth around the body without the need for cutting and construction. Technology therefore is the influencing factor on *how* the garments shapes are created. Narrow looms result in cutting and sectioning of the cloth to create a solution and wide looms mean that the wider cloth does not require any construction. This seems like a fitting theory for a study, which considers how a garment's design can be geared around its capabilities. It is also clear, that literature, which provides examples of garments displaying straight constructions, can provide valuable insights as to how to

approach designing pattern shapes that are restricted by straight bonded seam tapes.

1.3.4 Examination of appropriate methods of shape generation.

Burnham (1973) and Parker (2003) discuss and categorise the cutting practices used in a number of traditional garments and as with the approach to the kimono, many of these examples exhibit a number of similarities. Parker (2003) notes a prevalence of patterns cut from squares, rectangles and triangles providing visual material to exhibit the pattern constructions and resulting garment shapes. The authors also focus on a common practice of arranging the pattern pieces on the cloth in order to waste as little cloth as possible: attributing this to a respect for the weaver's craft. As the focus of Burnham's (1973) publication is examining how the pattern pieces of a number of historical garments would have been cut out of the traditional cloth widths, the visual material provided can be a valuable resource for this study. Applying this cutting practice to the study therefore could provide a solution to minimising or avoiding cloth waste. The first part of the literature review revealed that there are still cost issues associated with bonded construction and the machines are described as '…expensive and slow.'(StitchWorld, 2013:46). In order to mitigate for this extra cost, it would be worthwhile to avoid cloth waste where possible, to keep fabric costs down. This will however, need to be considered in much more detail and tested through the practice.

In line with the second aim of the study, the literature highlighted in this section, related to methods of shape generation was reviewed in order to understand and further explore ideas to inform a 3D design methodology. The literature formed the basis of sketchbook analysis through observational drawing to highlight relevant cutting practices to explore in the practice. See figures 8 & 9 (Etheridge,E. 2018) Images of all of the sketchbook pages used for this part of the review can be found in appendix 4 pages 32-41.

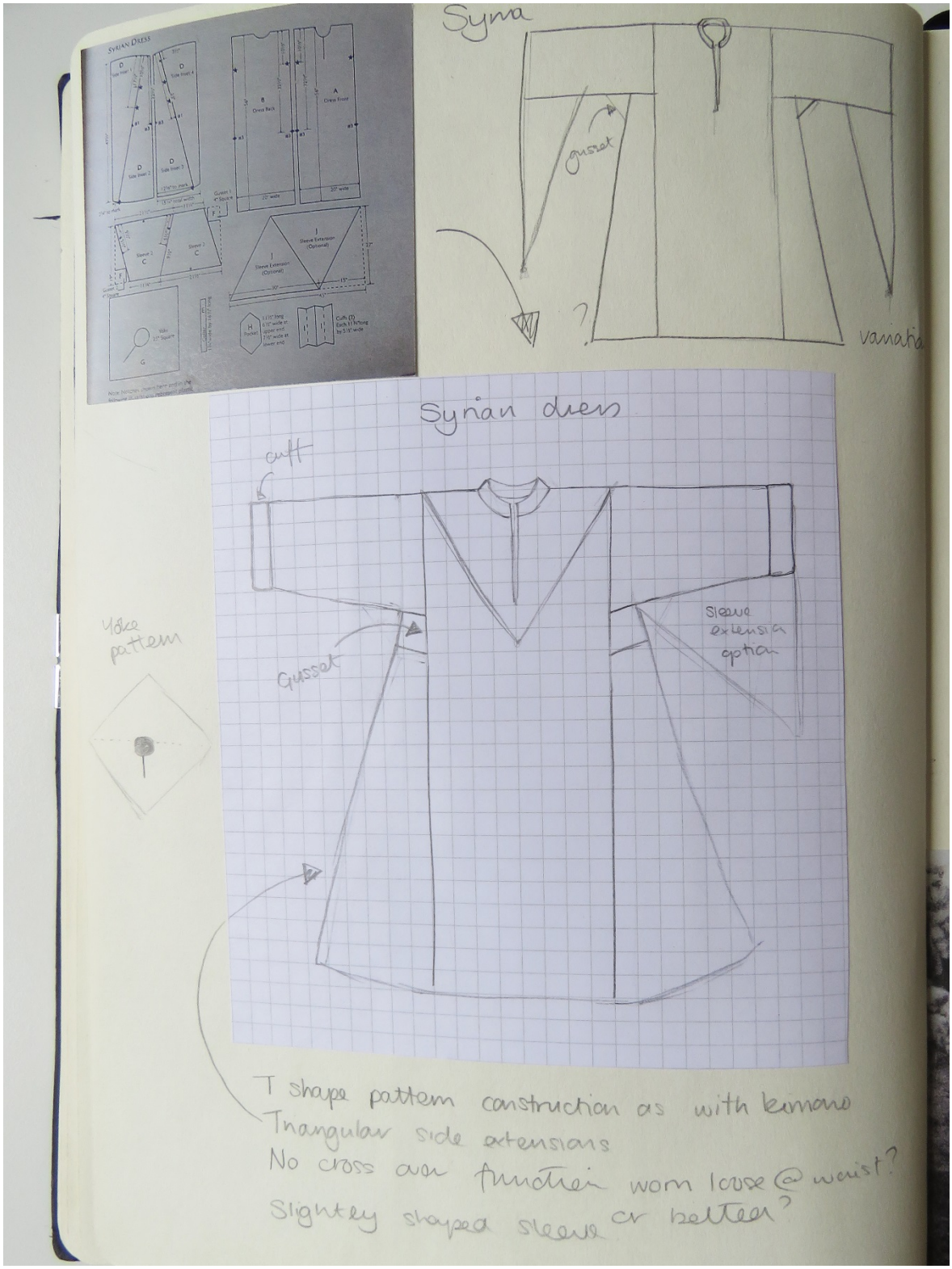


Figure 8-Sketchbook page examining construction of Syrian dress (Source Etheridge, E.2018)

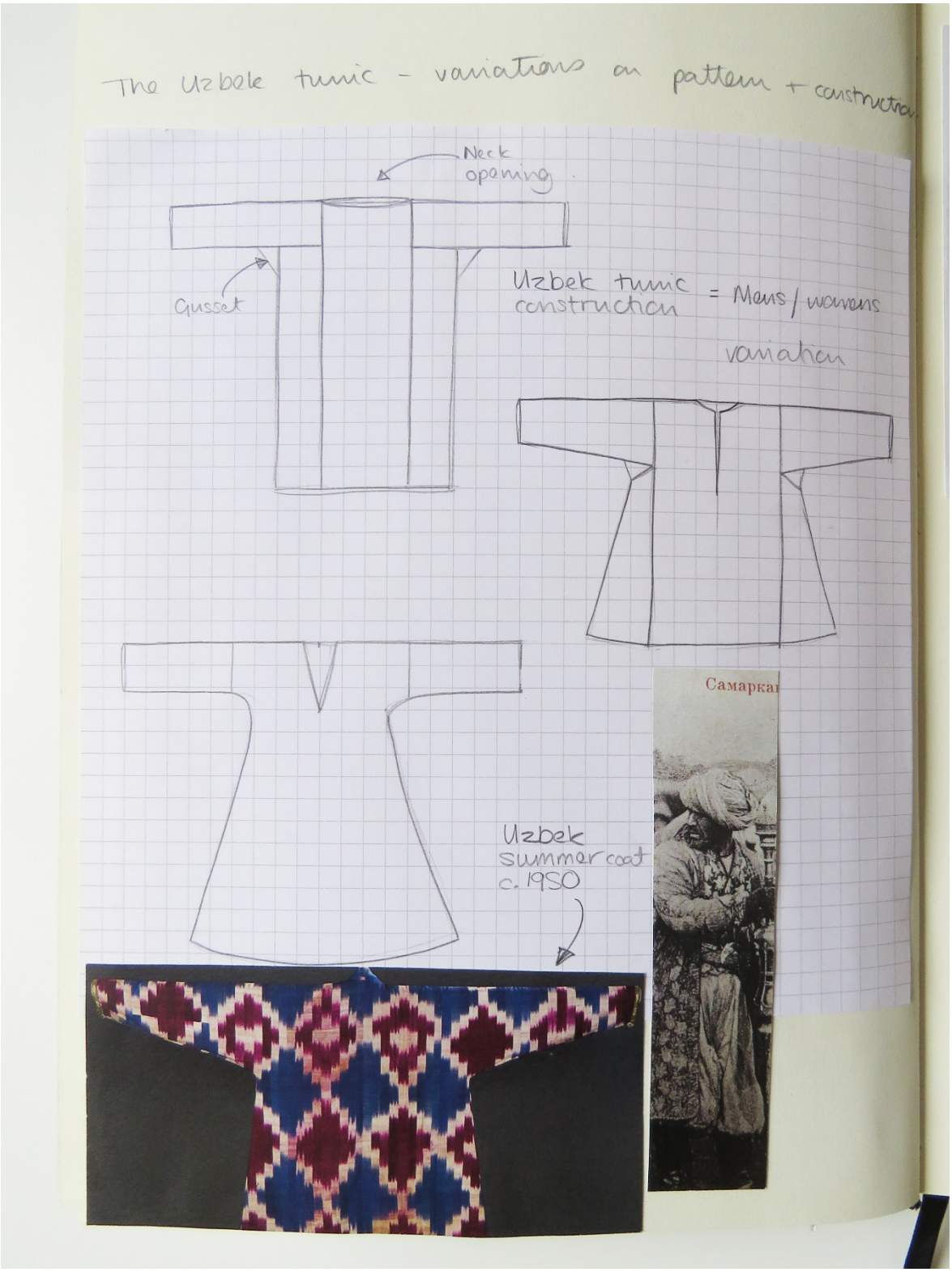


Figure 9 - Sketchbook page examining construction of Uzbek tunic (Source Etheridge, E.2018)

1.3.5 Designing with patterns.

Narrowing the literature review to more suitable shape making approaches revealed some key themes to explore:

- Designing garments around a technical consideration.
- Designing the shapes of garments to minimise / avoid cloth waste.

A review of more recent practice based research studies, revealed work stemming from many of the same garment sources examined in the sketchbook analysis of historical garments used for this study. Recent research focuses on the historical cutting practice of avoiding cloth waste in historical garment design which Burnham (1973) and Parker (2003) both note. Zero-waste fashion design endeavours to avoid cloth waste in clothing production by factoring it into the design process to highlight issues of sustainability in fashion (T. Rissanen and McQuillan, 2016). The work of fashion academics and researchers McQuillan (2005) and Rissanen (2013) proposes that in order to design zero-waste garments, the traditional design process must be adapted to plan out how the garment pattern pieces are to be cut out from the cloth from the outset. The process therefore, involves designing the garment at the same time as producing the pattern. Fashion academic and designer Roberts (2015) calls this ‘designing with patterns rather than creating patterns for designs.’ (Roberts, 2015:online). His work, although not primarily concerned with zero-waste, uses the process of pattern making to explore design ideas 3-dimensionally. His concept of subtraction cutting works with the uncertainty and the what ifs, of the pattern making process to generate unexpected outcomes. Working to a design sketch, he asserts can limit ideas.

David Telfer’s work, developed through his academic studies which he now continues alongside his work as a practising menswear designer; combines zero-waste fashion design the concept of minimal seam construction to reduce labour and energy consumption during garment production (2015). His seams dress, puts this concept into practice using laser welding technology to simultaneously cut and seam a dress, which wastes no cloth in its production (textiletoolbox, 2018). He does however note that his design process involves a careful balance between the aesthetic, the simplicity of the garment’s cut and fabric waste (McQuillan and Rissanen, 2015). As Telfer’s seams dress only incorporates one joining

technology: laser welding, opportunities for further exploration can be revealed in this study as a broader range of joining technologies are considered. The concept of minimising the amount of labour used in the production of a garment is pertinent for this study as the bonding techniques, identified as potentially being most useful for garment construction involve a costly and slow process (StitchWorld, 2013). If there are opportunities to consider fabric consumption along with the complexity of the construction, then this could further mitigate against the problems associated with the bonded construction. This may be an achievable aim, as many of the cutting practices, which have been identified as potential sources to inform the approach to cut for this research, exhibit minimal cutting but would require examination from this standpoint. Research around zero-waste fashion design has shown that there is a need to make adaptations to the traditional design process in order to consider waste and that these considerations can be incorporated when designing with patterns. When assessing how the capabilities of the joining technologies can be factored in to the design process; designing with patterns may offer an appropriate opportunity to integrate this strategy.

1.4 Secondary data collection & analysis.

1.4.1 Introduction

In order to summarise the process of secondary data collection for the literature review process, diagrams are included to illustrate the processes. The initial process of data collection on joining technologies provided a clearer underpinning for the latter stage relating to methods of shape generation.

1.4.2 Identifying new joining technologies.

The diagram in figure 10 shows the process used to identify relevant material for analysis relating to fabric joining technologies (Etheridge,E. 2002)

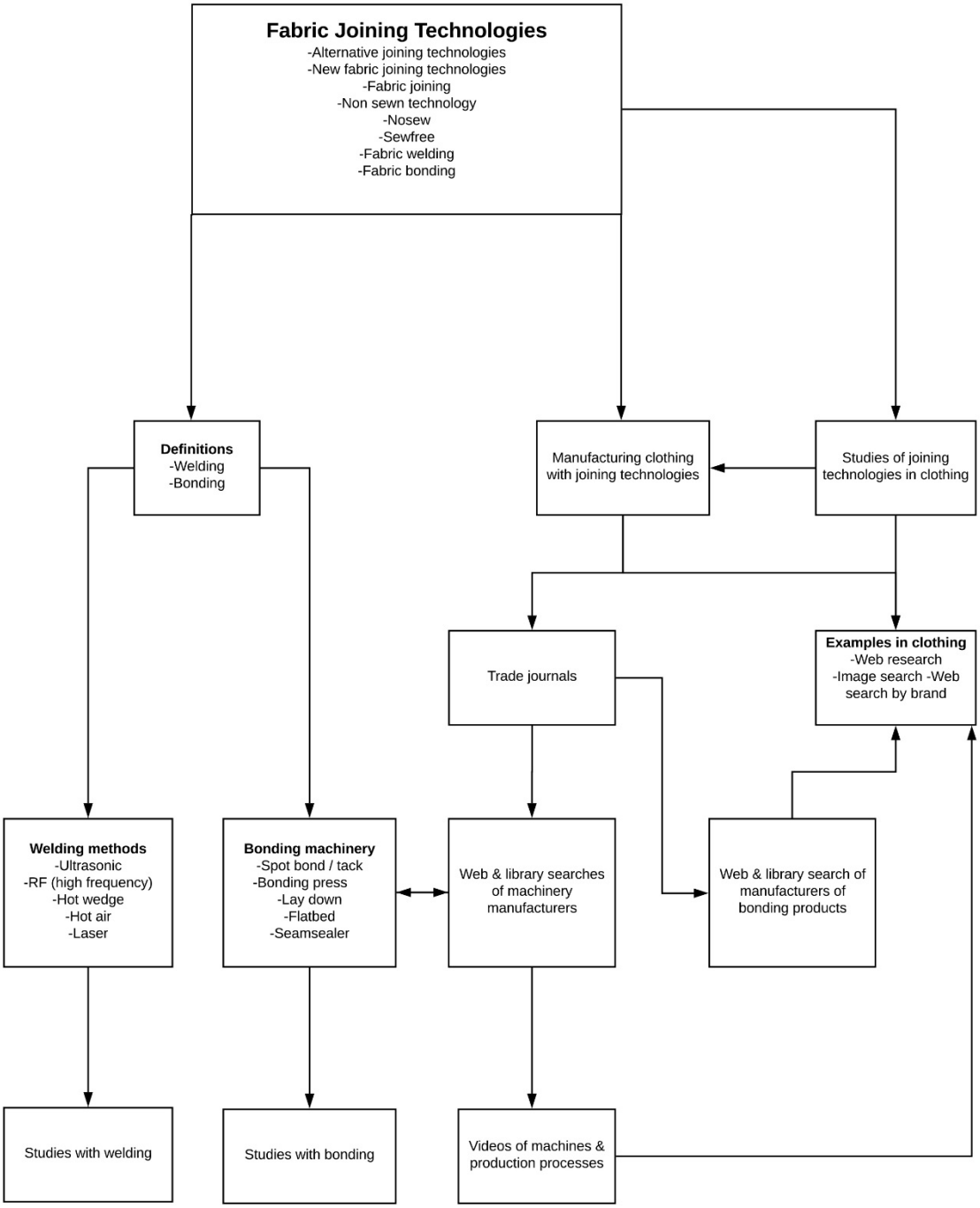


Figure 10-Process taken to collect data on fabric joining technologies (Source: Etheridge, E, 2018)

The first stage involved a library search using keywords. There was no common term in the literature to describe both the fabric joining methods of welding and bonding. Once it was established that this was the case, searches with the terms welding and bonding and fabric welding and fabric bonding revealed some variations. Searches were then undertaken using the terms alternative joining technologies, new fabric joining technologies, fabric joining, non-sewn technology, nosew technology and sewfree technology to identify a wider variety of literature. Some of the material selected for analysis related to fabric welding and bonding in broad terms and not specifically for clothing as this allowed for identification of a greater amount of information. The literature was used to identify the main methods used to join fabric components; welding and bonding and further subdivisions were revealed relating to the different processes. Once the main processes were identified, these could be used as keywords for further library search to identify more literature.

Using the terminology, identified through the literature which described basic method of fabric joining technologies as keyword searches, e.g ultrasonic welding and RF welding, material was identified that related to their use in the textile and clothing industries. The literature relating to textiles was selected for analysis as it mainly related to testing of seams with the methods and did not relate to specific textile applications. This literature also provided the names of manufacturers of machinery and some machine model numbers, which were then used for web searches to further understand the machine processes. These textile and clothing industry trade journals also provided the names of manufacturers of bonding products and these were used as keyword searches for library searches and web searches. The web searches revealed names of clothing brands who use welding and bonding methods in their clothes and a further web search, using these names as search terms was then undertaken to find examples of welding and bonding applications in clothing.

This process of data generation allowed for an initial outcome to be generated to inform the practice stages. Identification of such wide-ranging research meant that there was no clear guidelines to assess each method of welding or bonding against each other, which could prove useful for testing and assessing each method for the practice. Using content analysis to assess the material, a series of tables were

devised, dividing the welding methods up by machine processes. These can be found in appendix 1 pages 1-10. The headings of the tables were designed to relate to what the process involves, the fabrics that are suitable, the advantages and disadvantages of the methods and some typical applications in clothing. This was intended to be beneficial for the first stage of the practice in order to summarise the initial findings in a systematic and clear way. Through analysis of the literature relating to bonding it was clear that it was not possible to summarise the processes by typical methods, in the same way as the welding had been summarised. As bonding is a term describing the application of heat to an adhesive material to form a join with the fabric, the tables produced were categorised by machine. The fields in the table therefore describe the machine, a description of the process and clothing applications. As bonding methods are not restricted by certain fibre types, unlike welding, the field relating to suitable fabrics was omitted from the table. These can be found in appendix 2 pages 11-22.

1.4.3 Methods of shape generation for joining technologies.

The first part of secondary data collection informed the second stage related to identifying suitable shape generation methods for joining technologies. The stipulations, which underpinned the second stage of data collection, were taken by analysing the information from the tables, which summarise welding and bonding methods. To take into account any restrictions for the use of the methods in clothing, findings from studies related to seam strength were taken into consideration and any comments relating to any issues with particular joining methods were noted. The processes used for collection of this data can be found in figure 11(Source: Etheridge, E. 2018) .

Figure 11 - Process used to collect data for methods of shape generation (Source: Etheridge, E. 2018)

With this information, a search for garments, more suited to bonded construction with tapes, which use straight seams in their construction was prompted. The first keyword search terms used for the library searches were pattern cutting, pattern making and patterns to reflect common variations. As much of this literature was concerned with providing steps to adapt and make patterns for garment designs, it was therefore difficult to analyse in terms of patterns with only straight construction. Consequently, further library searches were undertaken to include the history of costume, fashion history and historical fashion to broaden the results and identify more suitable material. Using this information, further keyword searches using the term kimono (identified through the literature as fitting the shape criterion) allowed for identification of garments with similar shape approaches. The material provided some key principles of garments cut with straight seams and prompted a more selective analysis of the studies, identified through the initial library search around pattern cutting. This revealed a further term which was used for library and web keyword searches: zero-waste fashion design. This material provided names of designers and researchers who had used this process, allowing for further web and library searches.

The data collected for this stage was analysed to identify only garments with straight seam constructions. Images of these garments and the pattern pieces were recorded in a sketchbook and analysed visually, through observational drawing of the garments and patterns. These can be found in appendix 4 pages 32-41.

1.5 Key issues for consideration.

Literature was reviewed, in order to identify joining technologies and consider how existing approaches to methods of shape generation can inform a 3D design methodology for their use in garments. Prior to undertaking the practice stages of the research study therefore which will test out these findings, it is crucial to consider the key issues, which have been identified through this process.

As well as highlighting many of the benefits of using joining technologies, the studies showed that welding methods might not offer appropriate seam strengths

for garments. Bonding can offer superior seam strength but construction processes may be slow, also as tapes feature in many bonding applications they may be more suited to straighter seam constructions. There has been evidence to show that a clear understanding of the technical considerations of the construction method can provide a solid foundation when developing garment ideas. A holistic design process is described, to consider how each element can be adapted to suit the technical considerations however there is no prescribed strategy detailing how this can be achieved. Garments containing straight seam constructions feature heavily in some traditional, historical dress, providing possible examples of shape approaches suitable for bonded taped seams.

Through zero-waste fashion design, the practice of avoiding cloth waste in clothing production has been highlighted by recent studies, as sustainability comes into focus in fashion. The examples of traditional historical garments selected for further study reveal a consideration for fabric consumption and construction with an approach influenced by the loom technology. Methods of designing with patterns highlighted through the studies around zero-waste fashion design, show that this may offer a potential design approach for further exploration. This design approach could potentially allow for a more holistic view of the capabilities of the technology relating to the garment's design and construction. By designing in this way, there may also be potential to consider fabric consumption and simplicity of manufacture to mitigate against apparent costly and slow bonding production processes.

The following diagram in Figure 12 (Source: Etheridge, E. 2018) summarises the insights provided by the literature and illustrates how these were considered to formulate the four main design principles for exploration in the practice.

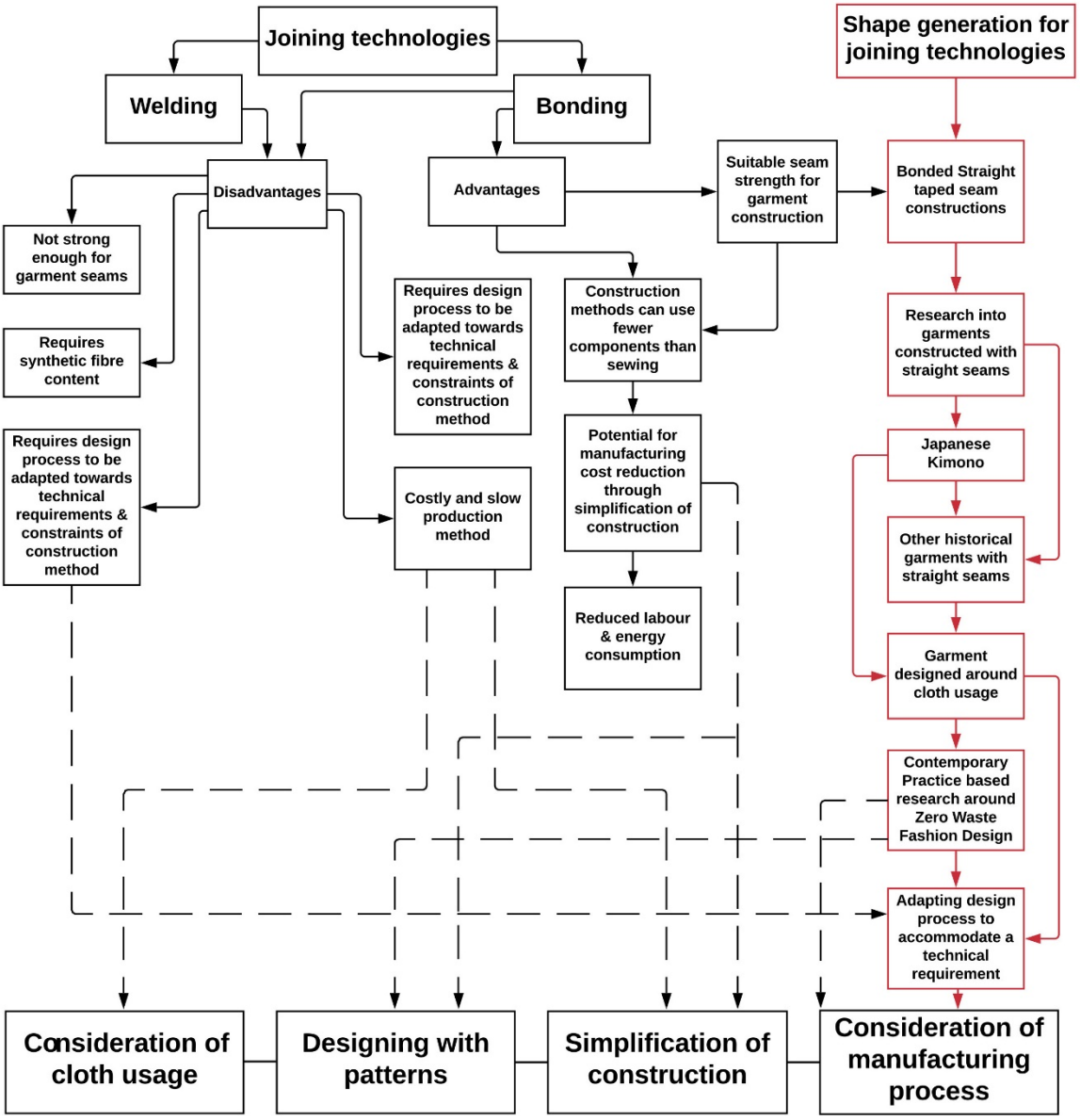


Figure 12- How literature review was used to develop design principles for practice (Source: Etheridge, E. 2018)

Methodology

Chapter 2 Methodology

2.1 Introduction

The following chapter details the methods used to achieve the objectives of the study:

1. To identify new joining technologies and test their application within the design and development of fashion garments.

2. To critically review literature relating to methods of shape generation that can inform an original 3D design methodology for new fabric joining technologies.

3. To apply an experimental holistic approach to the design and development of fashion garments that considers the technical requirements of fabric joining technologies.

4. To evaluate the outcomes of the practice using feedback from industry experts.

The study seeks to discover new ways of approaching pattern making by using a design practice-based approach to incorporate joining technologies into clothing and offer new possibilities for contemporary fashion. The research uses design as a mode of enquiry to investigate materials and processes and develop solutions for the application of this new construction technology. Scrivener (2002) argues that although pure practice does not qualify as research, making that sets out to generate '…novel apprehensions' (Scrivener, 2002:12) which comply with the accepted methods of generation from their relative discipline can be defined as research. The research incorporates qualitative methods to evaluate the results of the practice from subjects within the chosen field for the research.

2.2 Design practice-based approach

2.2.1 Design methodology

The design process is central to the study and experiential learning enabled by these experiences; inform further practice to provide a heuristic model for innovation within the practice. The use of design as a methodology is appropriate

as it benefits from the author's existing skills and knowledge in the design and development of clothing (as described in the *Background to study* pgs. 2-8). Tacit knowledge around the design and construction of clothing is used in the study to underpin the process of investigating the joining technologies and allows for appropriate strategies for design to be developed and solutions to be produced. Whilst studying design education in practice Laxton (1969) identified this as a crucial stage in the design process; one which he describes as filling a reservoir with experience to draw upon, in order to generate creative and appropriate design solutions.

As design involves an iterative process, it allows the garment design and development processes to be shaped by the findings from the research into the joining technologies and their application in clothing. Donald Schön (1983), the philosopher whose work examines the role of knowledge in professional practice describes design as a '…reflective conversation with the situation.' (Schön, 1983:76). He notes that the complexity of the design process, with numerous variables, can lead to further consequences and observes that designers become accustomed to responding to uncertain situations to form new ideas and appreciations. Taking a holistic view of the design process in relation to the technical requirements of the joining technologies, allows necessary adaptations to be made to the design and production processes.

2.2.2 Practice-based research

Candy (2006:1) defines practice-based research as an '…original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice.' The primary data for analysis is provided firstly by the practice. The researcher takes a central role and benefits from their positioning as practitioner and researcher, as they are able to understand the logic and intentions of the practice from an insider's viewpoint (Bolt and Barrett, 2010). As practice is central to the study, the process has been recorded in order to discover, understand and interpret the findings from the dual perspective of practitioner and researcher and to share with a wider audience for qualitative analysis. In 1927 the philosopher Martin Heidegger (cited in Bolt and Barrett, 2010) defined his notion of praxical knowledge as theories and ideas that result from practice as opposed to the concept that practice is the application of knowledge and theories. Through the

practice, praxical knowledge is generated which allows for a deeper understanding of how the joining technologies can be applied to clothing, which fits with the emergent nature of design as a methodology (Bolt and Barrett, 2010).

Skains (2015) claims that practice-based research methods are appropriate in cases where the specific question could not be explored by other means. The study seeks to discover how new fabric joining technologies can be incorporated into contemporary fashion garments and literature revealed scarce examples of such technologies in this market. It would seem apparent therefore, that a practice-based approach would provide the most appropriate way to provide a solution to the research question in the form of creative new ways of using a technology that has specific technical requirements.

2.2.3 Qualitative approach

It must be acknowledged that as practice-based research puts the practitioner in a central role, that the process will be shaped by their own individual knowledge and experience. In order to be objective when taking on the role of both designer and researcher consequently it is vital to understand one's own position. Giddens (1995) and Bourdieu's (1990) concept of reflexivity therefore becomes relevant. Noting that one's own viewpoint as a designer shapes the practice, process and outcomes and acknowledging the dichotomy between the subjective designer and the objective researcher. With this aspect in mind and in line with the fourth aim of the study, a qualitative method has been selected, in order to solicit feedback on the outcomes of the practice against the research question. As the literature review revealed that joining technologies are not currently widely used across the clothing industry in general, a small number of individuals have been selected for their specific expertise in relation to particular aspects of the field of research. Questions take the form of an open-ended questionnaire, which Kawamura (2011:67) claims can provide '…a rich source of additional qualitative insight..'

2.3 Methods.

2.3.1 Research tools.

The following tools were used within the research to evidence, analyse and record the practice for the purposes of the research:

- Photography to record processes and outcomes.
- Sketchbooks for visual recording and analysis to develop design ideas. Drawing to plan / test / develop design and construction techniques.
- Seam and prototype sampling to test technical and garment design processes.
- The process of reflection used within the practice to guide the process and more critical reflection of process and findings from the practice in the form of notes in sketchbooks.
- A questionnaire.

2.3.2 Research methods.

The following diagram figure 13 (Etheridge, E. 2018) shows the stages of the practice used to develop the final outcomes. To reflect the two main elements of the practice, the stages will be described separately. The first part will describe testing and production with the machines and the second will relate to the selection of a method of shape generation and its application to the design of the garments.

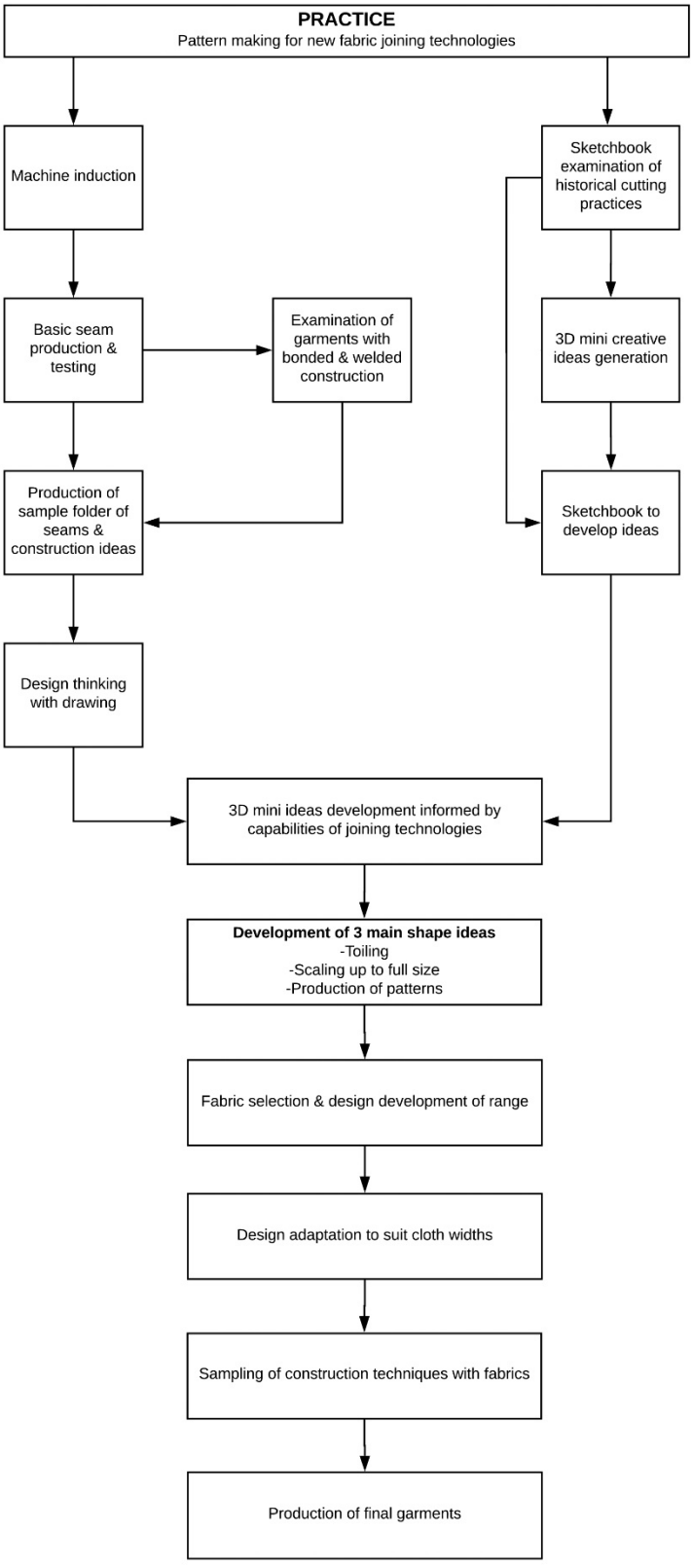


Figure 13 – Practice process used to develop garments (Source: Etheridge, E. 2018)

Machines : A machine induction was undertaken to learn how to use the machinery and produce some basic seams samples. These samples were manually and visually assessed by stretching, to check seam strength and elasticity. Four garments that contain welded and bonded construction methods were photographed and visually analysed to provide more information on how seam types could be applied to construction garments. See appendix 5 page 42.

A 100% white polyester scuba jersey was selected to produce all further samples in order that it would be compatible with welding and bonding methods and would allow for a clearer comparison and assessment of the various methods. In addition to basic seam samples, samples were produced which showed some basic garment construction components. These were recorded on sheets and compiled in a folder, images can be found in appendix 6 pages 43-68. The machines used to produce all the samples were recorded with details of which machines were used to produce each seam, alongside the sample; in order that they could be reproduced at a later stage if required. Suggestions of where the sample could be in a garment were also noted. A process of drawing was used to explore how these construction ideas could be applied to a garment and how they would work in practice.

Once the fabrics had been selected for the final garments, samples were produced of the seams and construction elements of the garments in order to establish the most appropriate machines and machine settings for manufacture.

Generating garment shapes: The sketchbooks examining cutting practices (Appendix 4 pgs. 32-41) were used to inform 3D miniature experimentations with cloth and were then recorded in sketchbooks and drawing was used to further explore ideas. (See appendix 7 pages 69-77) Using findings from the seam testing and the drawings, which explored how these could be applied to typical garment construction processes, further ideas were developed using 3D small-scale experiments. These ideas synthesized the findings from the research into joining technologies and the ideas development of appropriate shapes to allow for the development of design ideas suitable for joining construction methods. Three main ideas were selected for further development, as these showed a balance of shapes that could be applied to different garment types to produce a range of garments.

These ideas were developed further into full scale garments to produce prototypes (toiles) The zero-waste and simplicity of manufacturing strategies, identified through the literature were applied to these designs. Once suitable fabrics had been selected, and the cloth widths were defined, the designs were further adapted to consider the zero-waste design strategy. Garment patterns were produced and the final garments were manufactured.

Selecting industry experts for feedback:

To allow for feedback on the practice in line with the fourth objective of the study, key people with expertise relating to the field of the research were selected and approached for feedback.

Initially, key themes of the research were identified see figure 14 Etheridge, E. 2016)

Figure 14 - Selected research themes used to identify experts for feedback. (Source: Etheridge, E. 2016)

Using these key themes, a web search was used to review online biographies of potential experts to approach for feedback. Due to the specialist nature of the research area, the process identified few experts to target for feedback. Figure 15 (Etheridge, E. 2016) shows the selection criteria that was developed for identification of experts for the qualitative feedback in order to demonstrate the rationale behind the choice of each selected expert.

Criteria for selection of experts for qualitative feedback on practice outcomes				
Criteria	Expert 1 DT	Expert 2 JR	Expert 3 LJ	Expert 4 RW
Expertise and experience of the commercial use of joining technologies as a construction method in clothing			✓	✓
Experience of commercial fashion design	✓	✓		✓
Experience of practice based research	✓	✓		
Experience of using designing with patterns as a design methodology	✓	✓		
Current practitioner in field of fashion/clothing	✓		✓	✓

Figure 15 -Criteria used for selection of experts for qualitative feedback on practice outcomes (Source: Etheridge, E. 2016)

Once the participants had been identified, due to their location email was chosen as the most appropriate form of contact. The biographies of the chosen experts is detailed in appendix 9 on page 85 to further detail their expertise and experience in relation to the field of the research and the key themes of the project. As there was some variation in the expertise of the participants, a short open-ended questionnaire was chosen as the method of soliciting feedback. In order to encourage participation in the feedback, three questions were posed to the experts. The first two questions were identical and the third had two variations geared towards the expertise of the respondent in joining technology or designing with patterns.

To summarise the overall aim of the research and present the findings, photographs were taken of the final garments and a basic summary was produced; this was compiled into a project summary and can be found in appendix 8 pages 78-84. The project summary and questionnaire were sent via email to each expert. The full transcript can be found in appendix 9 pages 85-89.

Q1 The garments: The aim of the research is to develop and adapt approaches to pattern making to consider how new fabric joining technologies can be incorporated into contemporary fashion. My main objective was to achieve this by developing and adapting a design approach that considered the technical requirements of the construction method. Considering this as the project brief, what would be your comments on how successfully this was achieved through the resulting garments?

Q2 Viability of construction methods: Some of my findings from tests with the joining technologies was that they allowed for construction techniques not possible with traditional cut and sew methods. Do you think that using these new methods of construction can also bring new possibilities to creative pattern and garment design?

Q3 (Version 1 Pattern Cutting) Working method: As I was working with a technology that was new to me and required new thinking around the construction of the garments, I found it more appropriate to develop design ideas three dimensionally to be sure that they were technically possible. What have you found to be the advantages and disadvantages of working in this way, designing garments through patterns as opposed to creating a sketch to realise through pattern cutting?

Q3 (Version 2 Joining technologies) Working method: I have experience designing and making for traditional cut and sew methods. Through this project I have found that joining technologies require a completely new way of thinking and can actually offer many advantages over cut and sew methods in that some construction methods can be simplified. What have you found to be the advantages and disadvantages of working with joining technologies as a method of garment manufacture?

The responses were reviewed and categorised into feedback relating the garments specifically and feedback that highlights wider issues. These were then analysed for any recurring themes related to the aim and objectives of the study.

More informal feedback, which allowed for the development of the research project, was instigated through a paper presentation at an academic conference *The Second International Conference for Creative Pattern Cutting* on the 25th February 2016 (Etheridge, 2016) and an interview feature on the project on a trade website. These can be found in appendix 10 pages 90-104 and appendix 11 pgs.105-110 respectively.

2.4 Ethical considerations

Prior to use of the machinery for the practice elements of the research, machine inductions and risk assessments were undertaken and documented in accordance with the health and safety policies of the University.

The industry experts who provided feedback on the practice all completed and signed forms in which they agreed that through their participation, they were agreeing to their comments being used for the purposes of research and to be recorded in this thesis. The feedback has been reviewed in order that no sensitive data, relating to any companies has been included in this thesis.

Where appropriate, all sources have been credited within the thesis and referenced in accordance with the University's guidelines.

Findings

Chapter 3 Findings and Discussion

3.1 Introduction

The research examines how a design practice-based enquiry can be used to develop and adapt approaches to pattern making that consider new joining technologies for contemporary fashion. The findings related to each objective of the research study will be addressed in turn. Key insights from the practice will provide justifications for decisions made to produce the final outcomes.

3.2 Findings from secondary data collection.

3.2.1 Identification and classification of new fabric joining technologies.

The research revealed that there was no agreed, commonly used term to describe methods which involve joining fabrics other than stitching. The term fabric joining technologies or joining technologies therefore was used in the thesis to encompass this. Joining technologies describes two main methods: bonding and welding. The bonding process involves heating and applying an adhesive element to the fabric and applying pressure to facilitate the join. Welding describes the act of melting synthetic fibres together, then applying pressure and cooling to form a join. Typical methods include Ultrasonic, RF (high frequency), hot wedge, hot air and laser and relate to the processes used by the machinery. Some of the machinery used for welding is compatible with bonding products and can be used for the bonding process.

3.2.2 Application of new joining technologies.

The use of welding and bonding construction methods in clothing is currently limited to a few markets, which exploit the functional benefits that they can offer of waterproofing, sealing, weight reduction and a lower profile. Other benefits that the literature highlighted was simplification of some construction methods, compared to sewing and elimination of thread. Trade journals revealed that joining technologies currently have a number of barriers to entry for wider adoption in manufacturing. Some machinery is costly and slow and as there are cost implications for companies to adopt a new technology in terms of training and machinery, adoption of the methods into the wider clothing markets have been

slow. Studies showed that some welding methods were not appropriate for clothing construction as they offer poor seam strength, however results showed that bonded seams using appropriate fabrics offer superior seam strength to stitching, indicating their suitability for garments. A number of brands had successfully implemented joining technologies into their garments by inventing new construction techniques and adapting all elements of the garment's design to suit the technology.

3.2.3 Approaches to shape generation.

The literature had revealed that it was necessary to have a clear technical understanding of the technology before applying it to garments. Many construction methods differ to sewn seams, so careful considerations must be made around the constraints of the methods when developing and designing garments. A need to design the garment in a holistic way was described, but no clear steps were prescribed or suggested for the design process. For this study, the approach to shape creation was considered as an element of the garment's design that would require further consideration. As the initial research indicated that welding could not offer seam strength appropriate for garments, methods of bonding were reviewed and it was found that most applications involved the use of seam tapes. This suggested that straighter seam constructions would be more appropriate for garments and from the starting point of the Japanese kimono, a number of other garments were identified that contain straight seam constructions. This provided solid foundations for the analysis of cutting practices to inform the 3D design methodology. Other features of these cutting practices, noted by the authors was simplification of pattern pieces and therefore few construction seams. Another common practice was to cut the garment pieces to fit on the cloth width without leaving any waste. Further searches revealed that these same cutting practices had been explored through practice-based research more recently and had used a process of designing with patterns to implement these principles. As this process allows one to design the garment at the same time as planning its construction, it offered an appropriate opportunity to concurrently plan around the technical constraints of the joining technology whilst developing design solutions. As issues of costly bonding production processes had been highlighted through the literature, the potential to simplify construction methods and implement a zero-waste design

strategy to reduce cloth waste and simplify manufacture could mitigate against these problems.

3.3 Findings from practice.

3.3.1 Machine induction and basic seam testing.

This process provided the opportunity to apply the learning around the joining technologies. As had been indicated by the literature, the machine settings required careful adjustment to suit the particular fabric types. As the application of pressure is a crucial factor in achieving the weld or bond, testing revealed that fabrics with a flatter appearance and construction were more suitable. The literature had stated that an understanding of the joining methods and machinery was key, in order to design garments with their construction. Once this was established through the practice, it revealed that the choice of fabrics were limited so testing involved selection of only fabrics compatible with the joining technologies. Ultrasonic seams with a number of 100% polyester fabrics were tested by manually pulling them apart, confirming the results of studies indicating their unsuitability for garment seams. Despite this, the ultrasonic welding methods did however allow for a number of different seam designs, so this revealed that they could be suitable for decorative finishes in the garments.

3.3.2 Sample production

A single fabric was chosen for testing, made from 100% polyester jersey, as this was found to make the process of comparing the outcomes of the machine testing much clearer and meant both welding and bonding methods were possible. The secondary data collection had included visual analysis of seam types and applications in clothing, but as these were only images it proved difficult to gain a deeper understanding of some of the methods. Four garments were collected (see appendix 5 page 42) that contain welded and bonded constructions. By carefully analysing these artefacts visually, it was much clearer to see how some typical garment constructions such as converging seams, had been resolved. The intention of the sampling process was to produce basic seam samples on each machine to inform the design process. The findings from the garment analysis however, prompted further experimentation with the welding and bonding machines resulting in the development of garment construction samples. Swantko

(2004) and Gural (2012) indicated that clothing brands had invented new construction techniques to incorporate welding and bonding into their clothes. Rather than a purely technical exercise to gain experience with the machinery and provide a selection of potential seams for the design process, it was discovered that this was an effective way to generate construction ideas at the same time as testing the limits and applications of the machines and joining methods. This process therefore generated garment construction ideas. See fig. 16 (Source: Etheridge, E. 2018) which could then be further explored and applied to garment designs through the design development process.

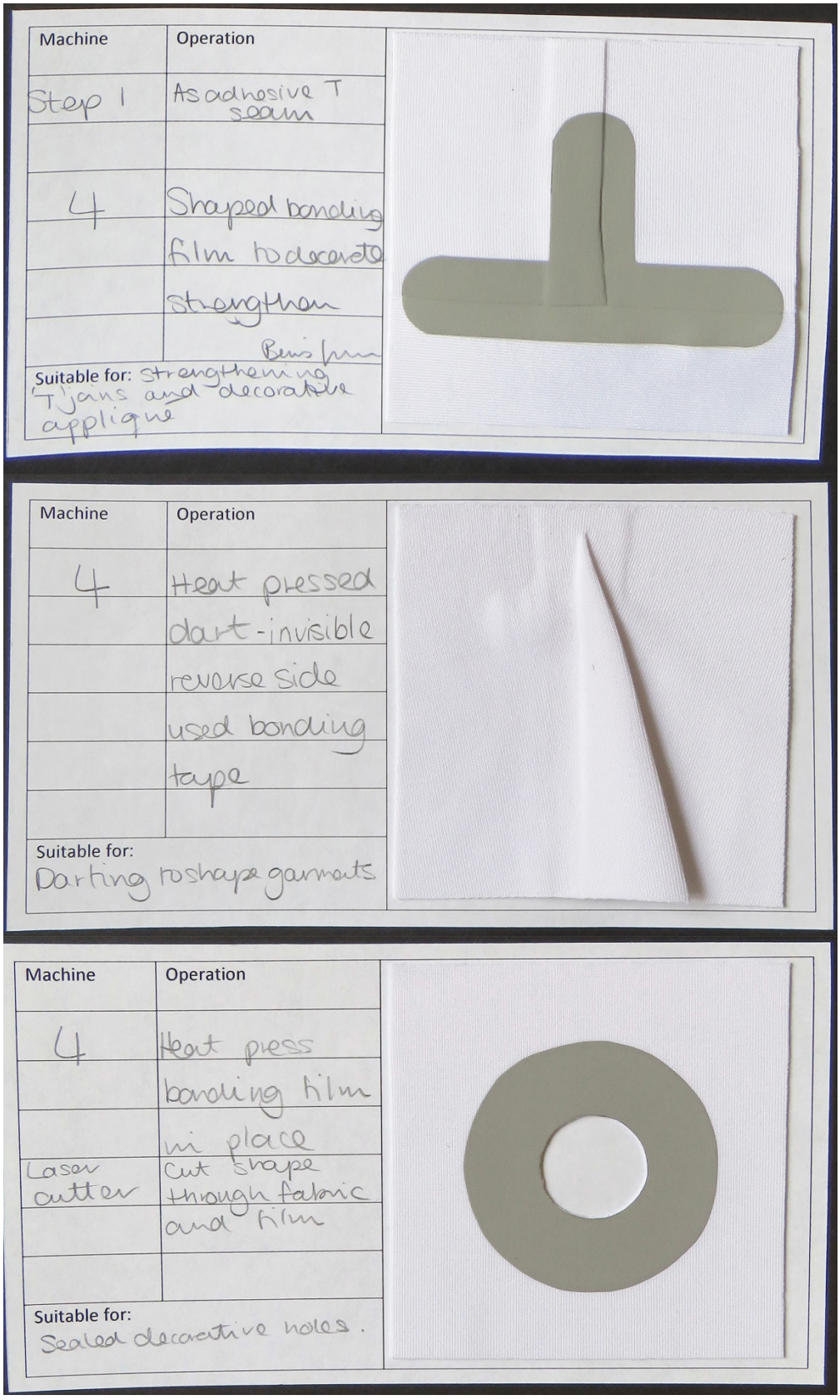


Figure 16- Samples of garment construction ideas (Source: Etheridge, E. 2018)

3.3.3 3D Shape making.

The material selected from the literature had provided methods of shape generation that use straight seam constructions and visual analysis in sketchbooks had allowed for further examination. The process of 3D shape making provided the opportunity to test these approaches and develop further creative solutions. The process allowed for generation of numerous creative ideas based on observations of the cutting practices. By recording these in sketchbooks (see appendix 7 pages 69-77) further ideas could be generated to inform the designs of the garments.

3.3.4 Design thinking with drawing: considering joining technologies.

Through the process of sample production, a number of garment construction and seam ideas had been created. Although creative design ideas were generated through the 3D shape making, once these ideas were reviewed, it became clear that resolving how these could be constructed with the different joining methods would require significant adaptations to the design. Although the ideas were based on straight seam constructions to accommodate the bonded seam tapes, as the sampling process had allowed for more understanding of the joining method; by this stage, it was clear that some ideas were not suitable. A possible solution would be to return to the samples to inform the design process. (Appendix 6 pages 43-68). By selecting some of the shape ideas from the sketchbook and then selecting potential joining sample ideas, a process of planning how the garment designs began. Informed by the experiences of using the machines and using drawing, to think and plan how the construction techniques could work with some of the shape ideas, around 50 pages of designs were generated. See figure 17 (Source: Etheridge, E. 2018) for examples. Research into shape approaches identified garments with straight seams, which were intended to accommodate the restrictions imposed by the straight seam tapes. During the sampling process however, experimentations with bonding films, which are supplied in sheets that can be cut to any shape, revealed a promising solution to accommodating some of the typical curved edges in garments such as the neck and armholes. This meant that in terms pattern shapes, there were fewer restrictions on the use of the use of curved shapes and opened up many more design possibilities.

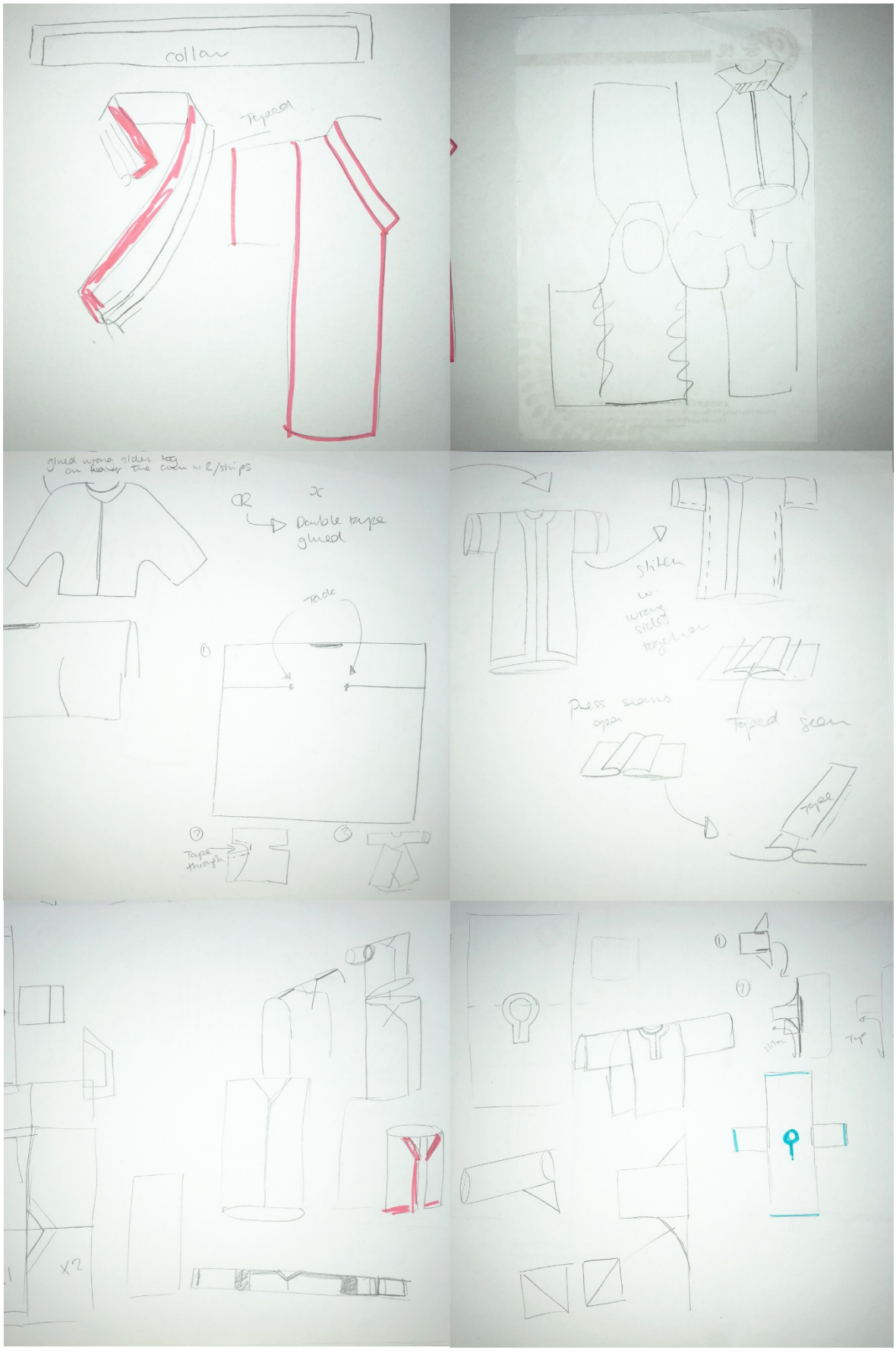


Figure 17 –Design thinking with drawing: applying construction ideas to shape (Source Etheridge,E. 2018)

3.3.5 Informed thinking: Construction and shape.

The drawings showed some potential design ideas but these had not been tested in practice. To combine the findings from the research and testing of the joining technologies with the pattern ideas, a further process of 3D shape making was undertaken. This involved producing shapes, whilst at the same time considering how the joining technologies could be incorporated. This was therefore a very conscious design process. As each idea was generated, a number of elements had to be considered: compatibility with construction methods, design aesthetic, fit with fabric waste minimisation strategy, simplification of construction. This echoed what Telfer had described about the process of incorporating zero-waste and minimal seam construction being a careful balance of each of these elements. (McQuillan and Rissanen, 2015) Owing to this, very few viable ideas were generated. See figure 18 (Source: Etheridge, E. 2018)

Figure 18- Informed thinking developing viable design ideas in 3D (Source Etheridge, E. 2018)

3.3.6 Developing a holistic approach to the design process.

Seram and Cabon (2014) had stressed the need for technical knowledge to underpin the design development, pattern cutting, selection of fabric and construction techniques of garments with ultrasonic welding. At this stage, it was clear that bonding methods also require the same foundations. Even though some 3D design activity started early in the practice, it was only once the joining technologies had been fully tested and sampled that a clearer understanding of their constraints could be established and therefore applied to the design process. Placing the capabilities of the joining technology in the centre of the design process therefore is a key strategy to developing garment designs. Thinking in a holistic way about every element of the garment's design and how it can be affected by the constraints of the joining technology was found to provide viable design solutions.

3.3.7 Fabric and applying zero-waste strategy.

As the design process had evolved, a number of stipulations had developed for the garment designs. The zero-waste design strategy had evolved from the pattern research and was intended to counteract issues identified with slow and costly bonding processes. As the designs had to be very carefully planned around the capabilities of the joining technologies, it became clear that it was not possible to also apply a zero-waste design strategy. Therefore, it was found that a compromise, which planned for the minimisation of cloth waste would be a more suitable strategy. Three key shape ideas, generated from the final 3D shape making exercise were scaled up to full size and produced as prototypes (toiles). Through design drawing, the basic design ideas were developed into a range of garments by varying length and selecting a variety of fabrics. The findings from the sampling process informed the fabric selection and imposed particular stipulations. Fabrics with flatter constructions, that could withstand the pressure from the machine and made from majority synthetic fibre content in order to incorporate welded decorative edge finishes on the garments were chosen. The widths of each cloth then had to be considered with the garment design, to implement the process of fabric waste minimisation. This involved a process of adapting the design of the garment and the width of the initial toiles, to plan how they could be cut out on the

chosen cloth, to minimize fabric waste. This additional step in the design process meant that variations on the jacket design had to be devised, by adapting sleeve and jacket length to suit the cloth. See figure 19 (Source: Etheridge, E. 2018)

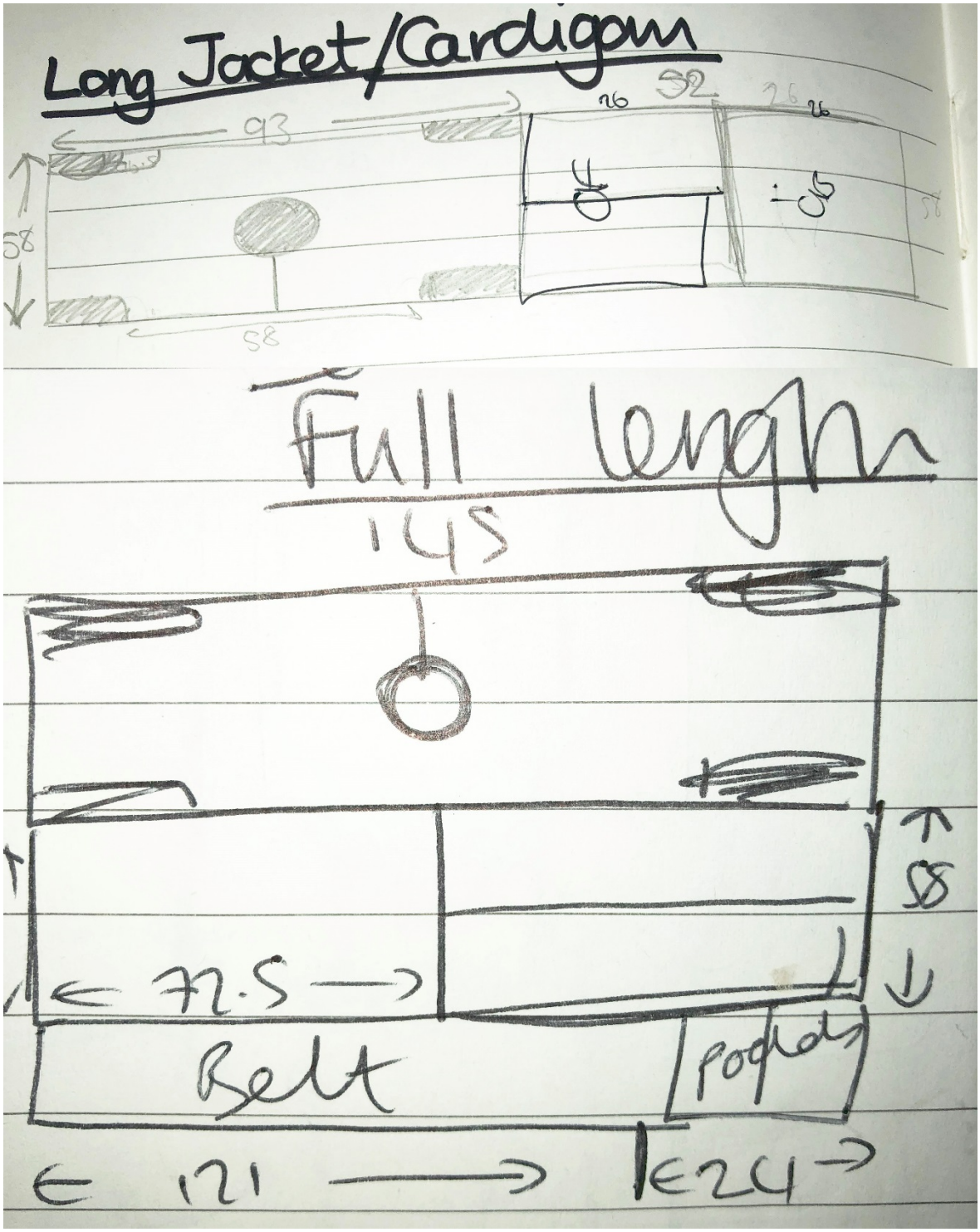


Figure 19 –Adapting jacket design to suit cloth width (Source: Etheridge, E. 2018)

3.3.6 Production of garments: Constraints.

Prior to the production of the final garments, samples of the various construction methods and finishes were produced with the intended fabrics, to note the machine settings and test the viability of the construction methods. No problems were noted and production of the final garments commenced. The use of bonding film on the edges of the jersey fabrics meant that this provided a sufficient finish to seal the edge of the fabric thus preventing fraying. Sampling of this technique initially presented no problems. Two of the fabrics were comprised of two layers of knitted fabric with a connecting layer in the middle. The primary choice for the fabric was aesthetic, as it had an appealing drape and handle and fitted with the intended design aesthetic for the range. Once the garment was handled repeatedly however during production, the underside of the fabric without the bonding film begun to fray, applying tape did not offer a solution, as the curves were difficult to manage and adding an extra layer of film to the underside made the edges stick together unevenly. Laser cutting all the pattern pieces offered a viable solution, as it sealed the edges enough to prevent fraying. Adding another step to what was intended to be a garment with minimal construction processes however, compromised one of the key design intentions for the practice. These fabrics were intended for use in the majority of the garments in the collection and due to time constraints, it was not possible to source alternatives so all the pieces in these garments were laser-cut before production. There were issues with some of the thicker parts of the jacket seams constructed on the flatbed-bonding machine. When they were fed through the machine, the thicknesses caused them to slow and the hot air caused scorching to the seams. The bonding press offered a suitable solution, although due to the restricted size this had to be done in several stages. When the vests and dresses were manufactured, the same technique was used effectively as the seam tapes did not scorch and the press applied an equal amount of pressure across the tapes so they produced a very strong bond. It was therefore possible to manufacture the vests with only two pieces of equipment, the spot bonder to tack the tapes in place and the heat press to apply the films and seam tapes. Ultrasonic welding, which had been identified as an unsuitable method for seams production, provided an effective way to add a decorative effect to the belts.

3.3.7 Applying a holistic approach to the design of fashion garments.

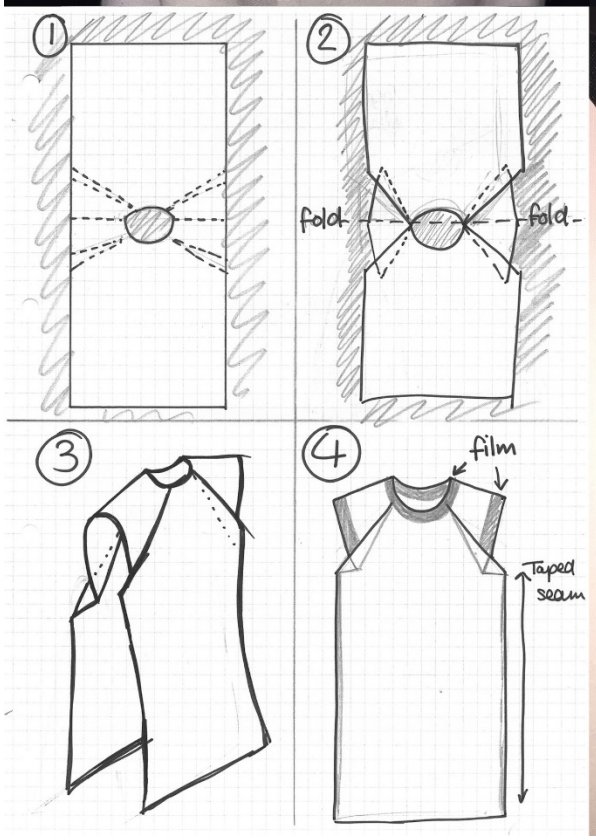
The garments designed for this research project show how new fabric joining techniques can influence the processes during the design and development of garments. Taking a holistic design approach to consider their capabilities was found to yield new design aesthetics, as well as the need for new thinking around pattern and shape making.

The process of designing the final outcomes was only possible once a clear understanding was established through the practice, that the capabilities of the joining technologies informs every choice in the garment's design and development. The garment produced for this practice-based study therefore embody the knowledge gained from the research process. As the design methodology evolved, these technical considerations became the central element to every aspect of the garment's design. Once an appropriate approach to shape generation had been selected, creative shape concepts were developed and evolved to consider garment construction ideas developed through testing with the machinery. A design brief evolved that had many stipulations, firstly due to considerations around the technical capabilities of the construction and secondly to counteract some of the issues identified as wider problems around manufacturing with the technology. This presented problems along the stages of the design process, as it limited the design possibilities. Once a clear design methodology had emerged which rooted the technical considerations of the joining technology in every aspect of the garment's design, appropriate creative solutions were generated.

The three core cutting principles generated from the practice provided a number of variations for garments types. The application of a fabric waste minimisation strategy allowed for simple modifications to the vest, dresses and top shapes but affected the design of the jacket shapes, which were adapted to accommodate this.

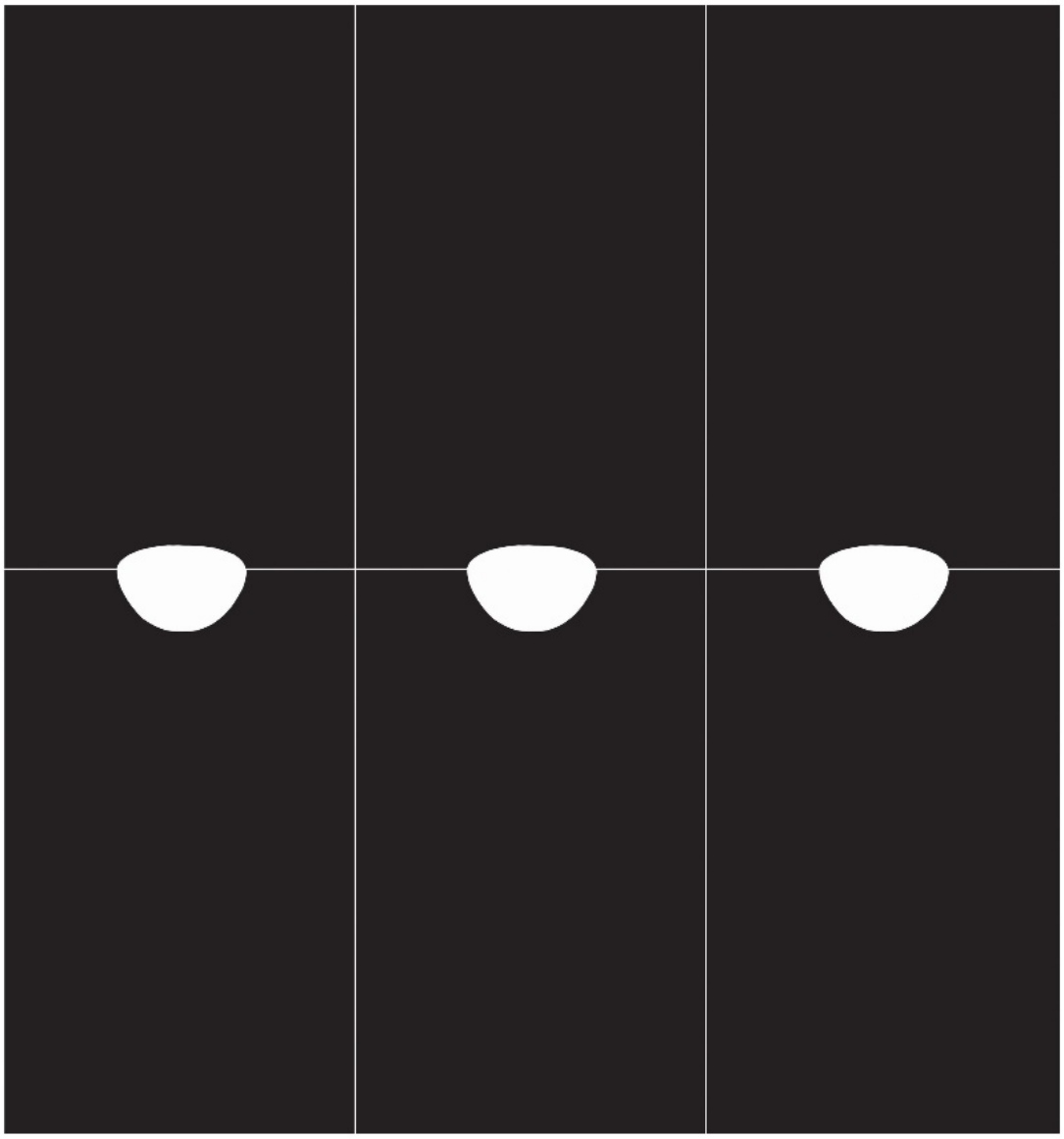
The garment construction methods allowed for elimination of seam and hem allowances by using edge to edge seam tape constructions and through application of bonding films to hems and edges. By reducing the amount of fabric used for garment construction this also complemented the fabric waste minimisation and

the simplified construction methods to mitigate against some of the problems associated with bonding production processes.


1
2
fold
fold
3
4
film
Taped seam

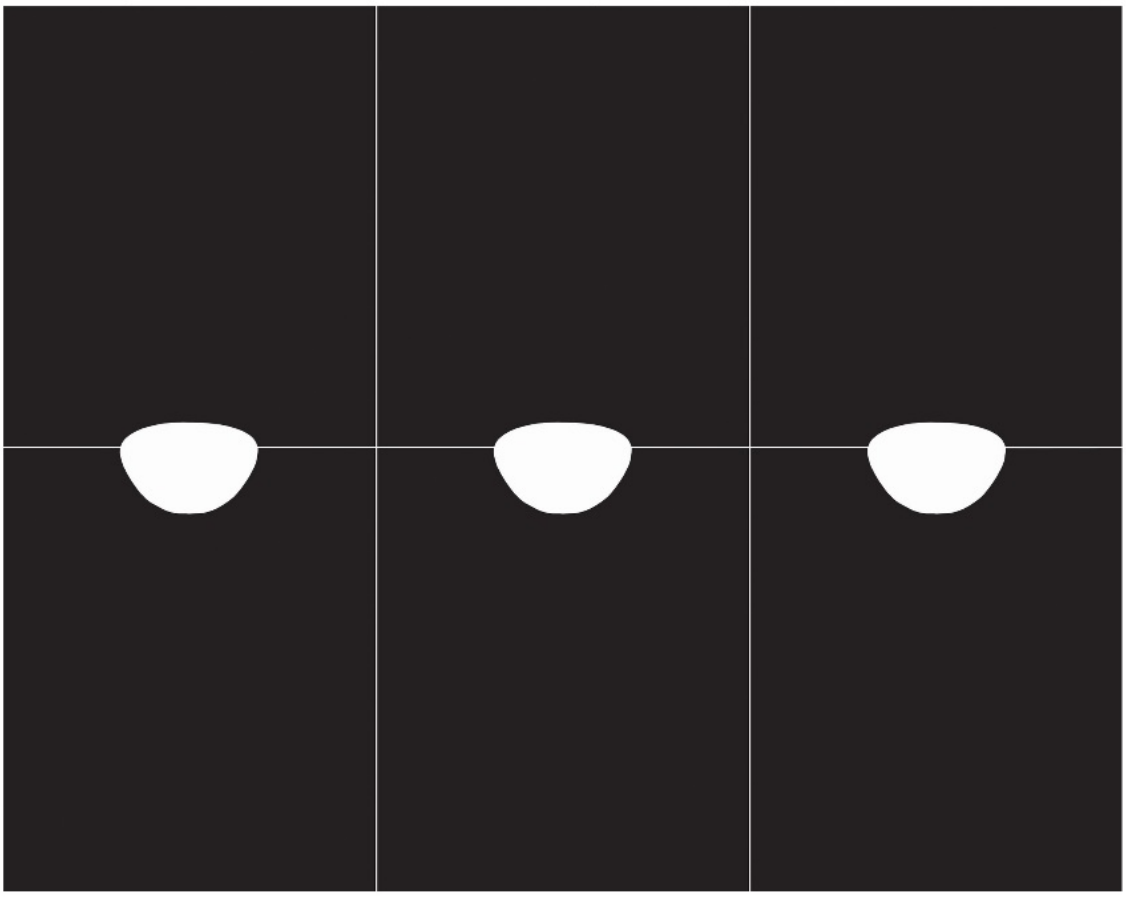
Dress

Pattern layout across width of cloth: 186cm required for 3 garments.



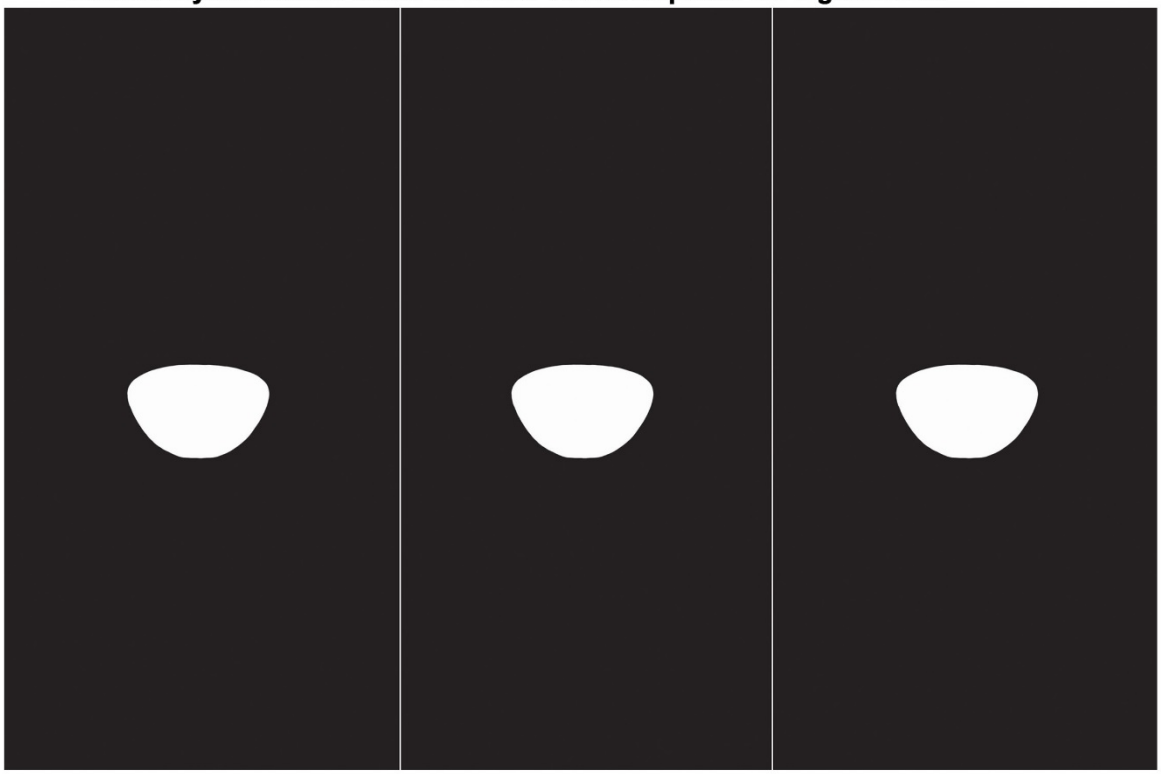
Mid length top

Pattern layout across width of cloth: 140cm required for 3 garments.



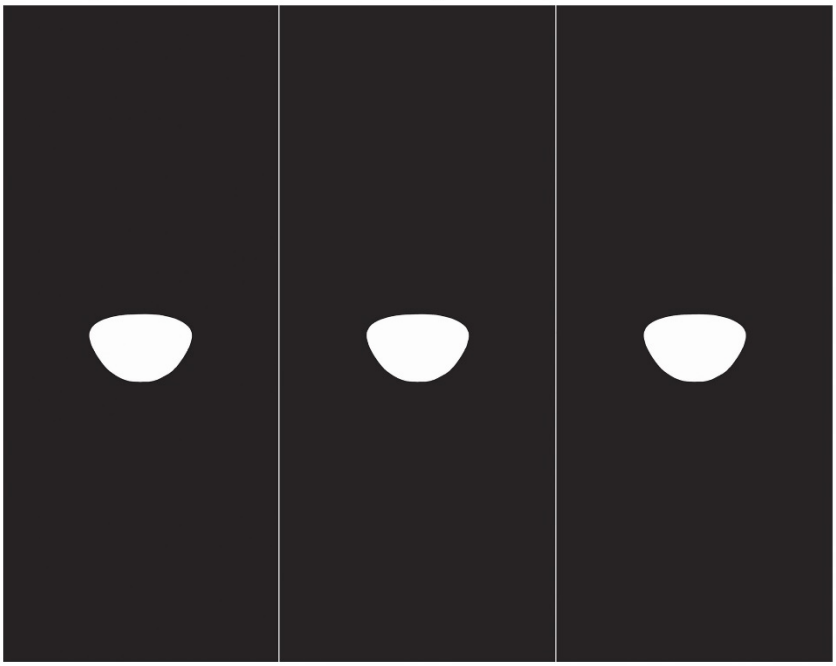
Short top

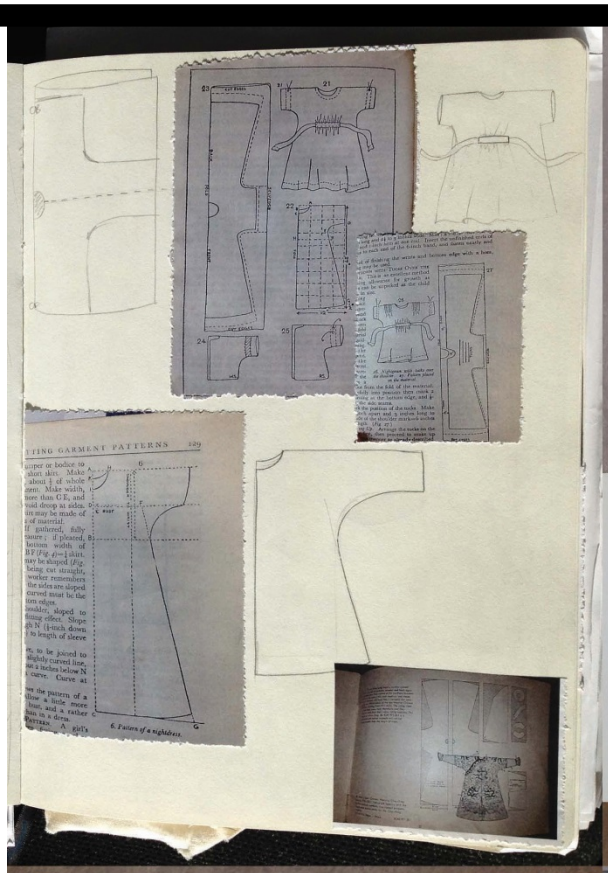
Pattern layout across width of cloth: 112cm required for 3 garments.



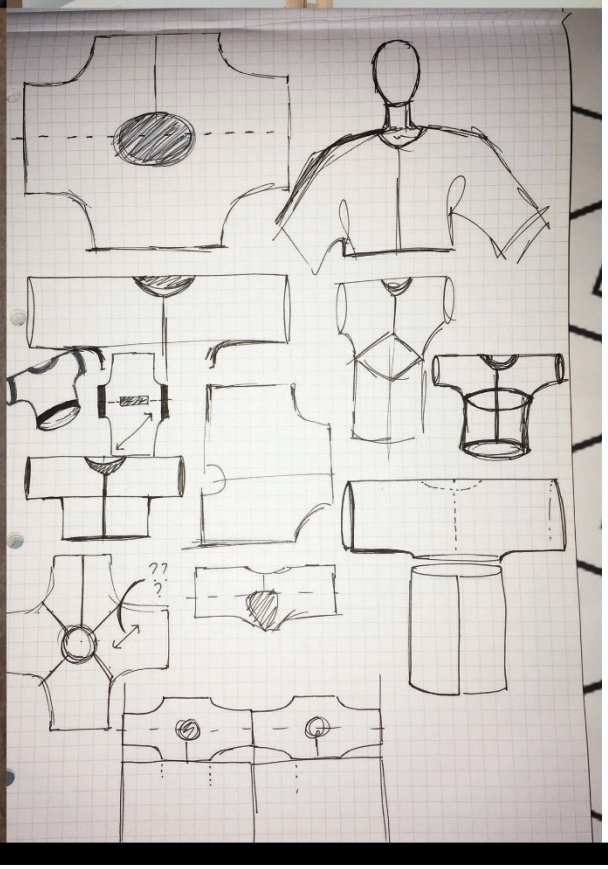
Unstructured top

Pattern layout across width of cloth: 140cm required for 3 garments .



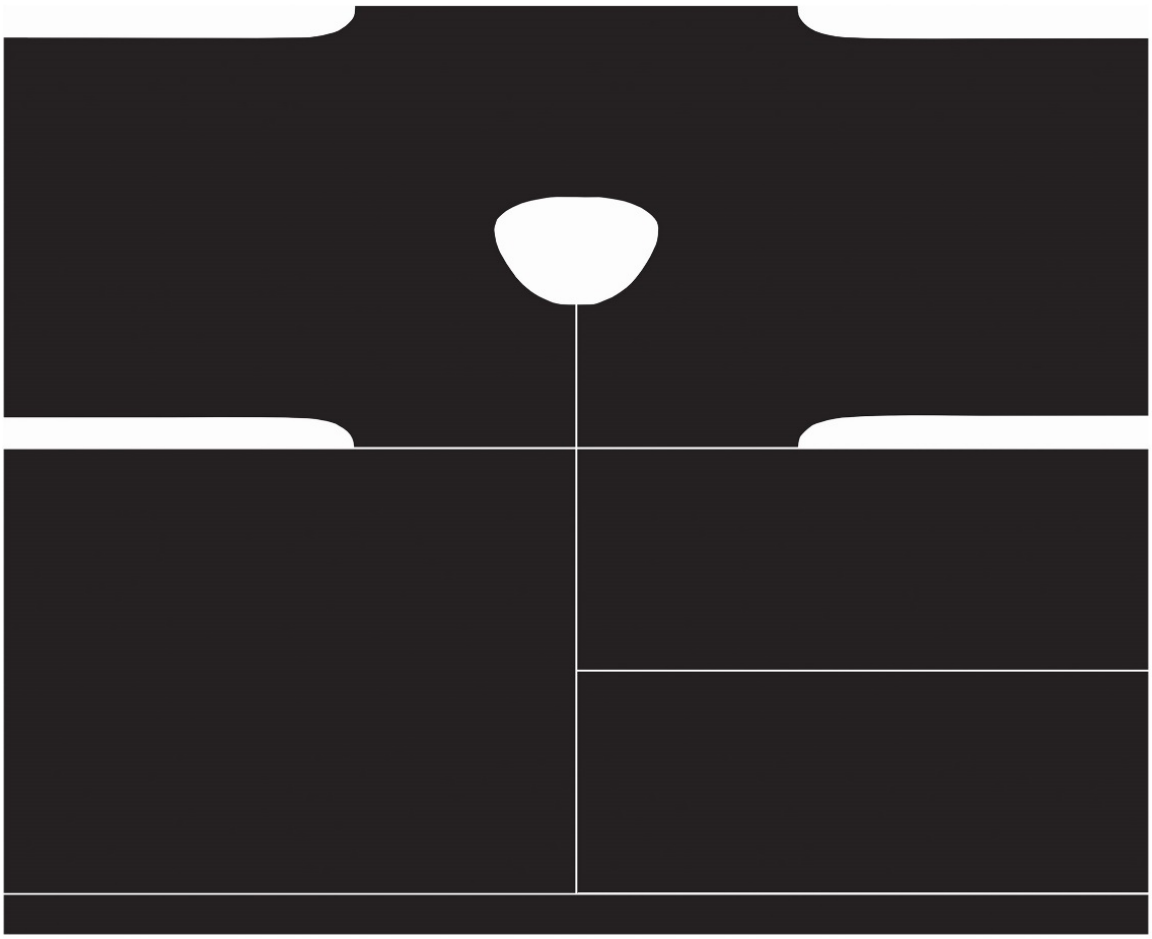

TTING GARMENT PATTERNS 129
6. Pattern of a nightdress.





Coat

Pattern layout across width of cloth: 122cm required per garment.



Cardigan

Pattern layout across width of cloth: 58cm required per garment.

Cropped jacket

Pattern layout across width of cloth: 58cm required per garment.

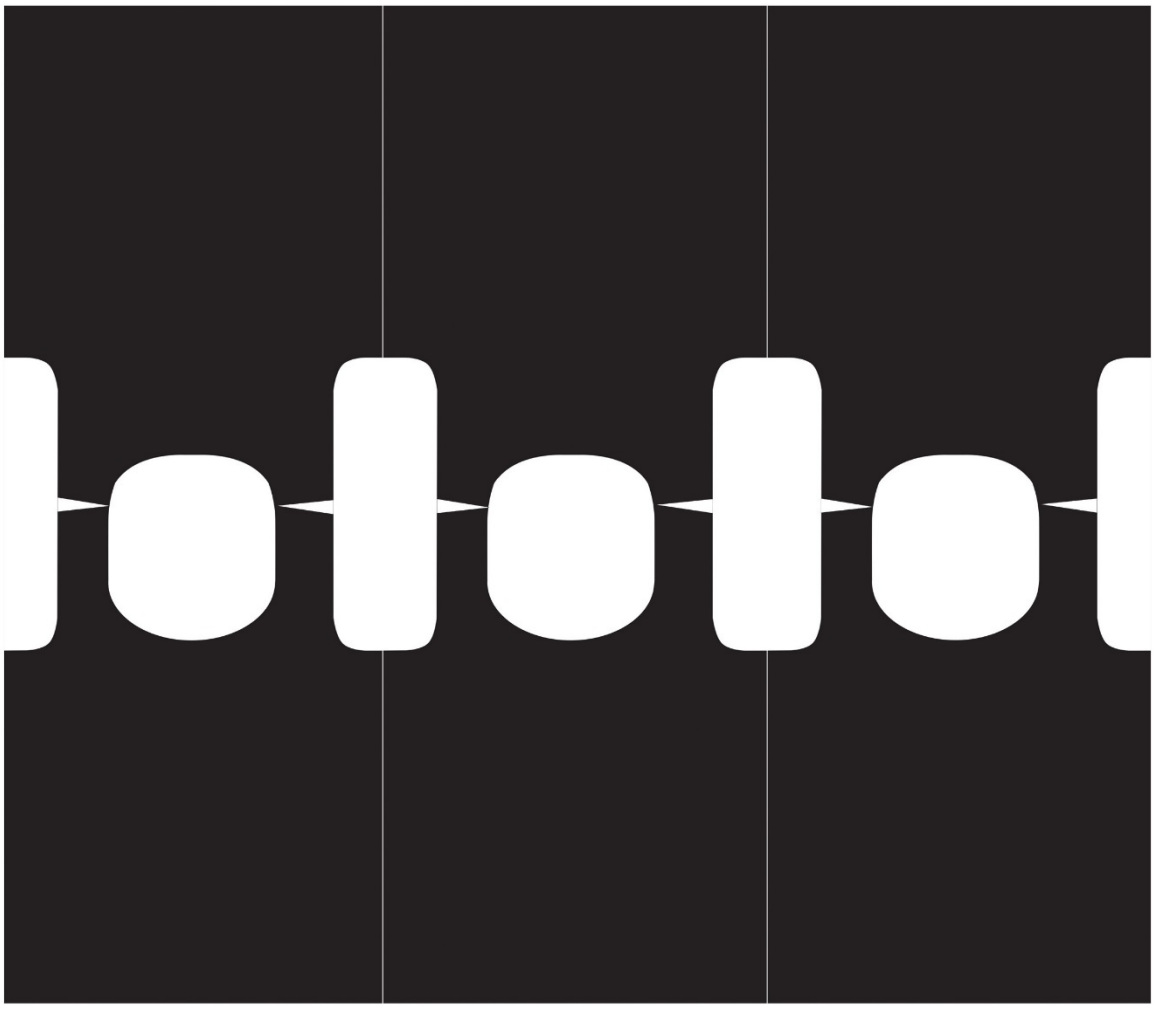
Shrug

Pattern layout across width of cloth: 58cm required per garment.


76cm
30 in
C
D
B
A
db
43cm
17in
9. Woman's shirt. Ukrai
arly 20th century. White
mbroidery mainly in yell
Gift of Miss Amice Calve
430.2

Vest

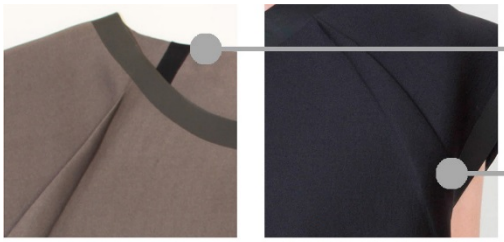
Pattern layout across width of cloth: 130cm required for 3 garments.



Belted vest

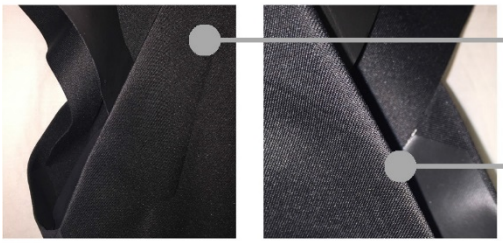
Pattern layout across width of cloth: 148cm required for 3 garments.

Construction



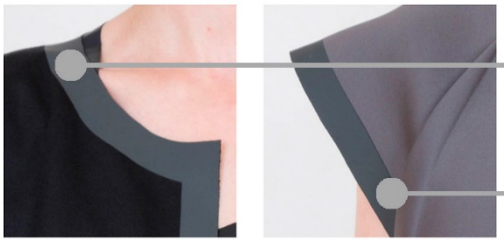
Fabric tape bonded to reverse of fabric to form dart.

Dart shapes cloth from neck edge to underarm.



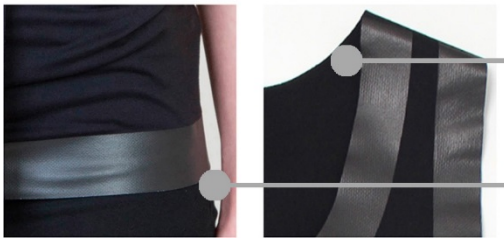
No visible construction of dart from right side of fabric.

End of dart is folded into underarm and forms edge of sleeve.



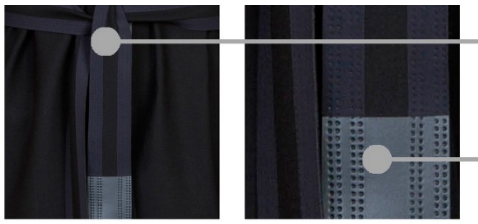
Bonding film applied to edges of garments to finish and decorate with no seam allowances

Neoprene pieces laser cut with bonded film on edges of garments.



Film bonded on outside edges of fabric only leaving smooth fabric edge next to skin.

Film stretches with elasticity of fabric.

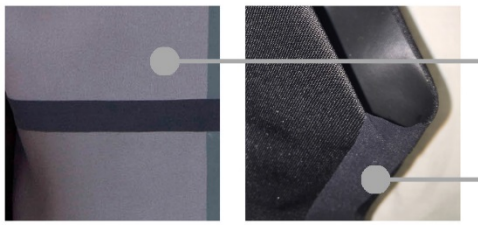


Bonding tape applied to long edges of belt.

Topstitched with lines of ultrasonic welding.

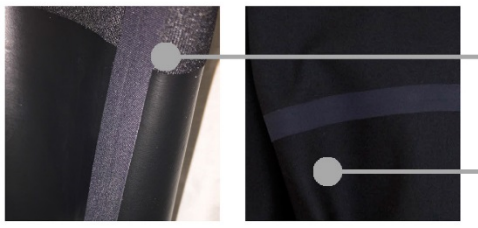
Optional belt to shape and fit garments.

End of belt reinforced with bonding film, folded over edge.



Flat edge to edge seams formed with bonding tape.

Garments cut with no seam or hem allowances.



Low profile seams.

All straight seams formed with tapes.

3.5 Expert evaluation.

In order to fulfil the final aim of the study and take a broader approach to drawing conclusions from the research, feedback on the practice was sought from subjects with expertise relevant to the study from within the chosen field for the research. This section presents the findings from this evaluation and considers other key issues relevant to the research.

A summary of the project was created, in order to provide the details and results of the project for the experts (See appendix 8 on pgs.78-84). Three questions were asked of each of the four experts, two which were identical and one which related to the individual's area of expertise (Full biographies of the experts, the correspondence details and completed questionnaires can be found in appendix 9 pgs.85-89). By analysing the feedback, as expected considering the expertise of the chosen participants and the questions posed; the broad themes that emerged were related to issues associated with using pattern making as a means of design and manufacturing with fabric joining technologies.

The responses relating to aspects of the garments specifically are presented here in summary:

The overall response to the question on how well the aims and objectives of the practice had been achieved through the garments was very positive. The experts considered the collection to be aesthetically directional, commenting on the clean contemporary look of the garments, considering them to be highly commercial and wearable for a wide range of consumers. One expert felt that the clothes were seasonless and captured an aesthetic feel of the athleisure trend. They felt that the technology had been used successfully for both practical effect; to finish the edges of the garments without the need for facings or hem and to add to the overall aesthetic. It was noted that as well as offering an aesthetic appeal, the construction methods also infuse technology into the garments, offering benefits that sewing can't offer. Feedback showed that the project is a worthwhile exercise to push the technology and the intentions behind it. They highlighted that the techniques had been used to good effect in the work to simplify production and reduce the waste from the yield of the fabric. One respondent felt this shows an understanding of the current needs of the industry related to innovation and sustainability and brings

advanced manufacturing into a new arena. They stated that the approach to pattern making allows the production to be simplified and that the technology offers new possibilities to pattern making, as this can change the structure of the garments and the design process.

Issues that were raised related to the collection were around how these outcomes could be relevant to a designer without skills relating to pattern making and the joining technologies, and also how they would relate to the day to day industry. The experts also highlighted that it would be important to conduct wearer testing to see how the garments would perform and whether through continued wear and laundering the aesthetic would change. As the design of the garments aim to simplify manufacturing processes, one expert pointed out that this may only be achieved in the long term, if at all. Both of the individuals with expertise in joining technologies highlighted that the higher production costs of welded or bonded garments is a barrier for brands They pointed out that the proposed production efficiencies would only be achievable through development of skilled labour and investment from factories and as the costs may initially go up, they may not choose to invest.

Some of the wider issues, not related to the garments directly were highlighted through the feedback. One expert discussed the use of pattern making approaches that consider manufacturing efficiencies, stating that in practice they can take time to develop and can compromise the aesthetic. Another of the experts emphasized the same issue, saying that if the goal is to consider efficiencies, then the most important thing is to make sure that the garments look good otherwise, there will be no audience and the product cannot deliver on its promises. The expert who has the most experience using the pattern making process to design garments stated that this way of working can bring discoveries not possible when designing with sketches. He believes that working in direct contact with the material enables one to learn from the process and foresee any problems, which ordinarily may not be discovered until the sampling or sealing stages of manufacturing. He went on to describe how working in this way could be applied to the industry as long as construction of the prototype is well represented through photography or sketches to aid visualisation for manufacturing. The individual with expertise related to manufacturing with joining technologies expressed that the biggest barrier to entry

for wider adoption of the methods is cost. Stating that her company's belief is that many of the applications of bonding are more efficient, requiring less material to manufacture however, these benefits may only be seen once factories have invested in machinery and developed skilled labour.

The emerging issues from the feedback relate to how elements of the practice could be applied to real world industry situations. The pattern making methods used were intended to suit the capabilities of the construction technologies and also exploit the manufacturing efficiencies offered by the technology. To further exploit the efficiencies, the designs were adapted to consider the usage of the cloth. The results of the feedback show that focusing on the manufacturing efficiencies alone in the garments requires considerable skill and investment on the part of the manufacturers. Claims made around efficiencies would only be beneficial and worthwhile investing in, if there is a real benefit to the product of using bonding or welding over sewing. If the designs of the garments were affected by the cloth usage, and this had to be carefully considered when designing and developing the garments, it seems that increased development time would be costly in an industry setting. This cost would have to be considered against the costs saved through efficiencies with the cloth and with manufacturing efficiencies. The strongest message from the feedback is that if a product promises to deliver on a number of aspects, then it must be desirable to the consumer otherwise it cannot deliver on the claims.

3.6 Discussion

The research aims to examine how a design enquiry can be used to develop approaches to pattern making that consider new fabric joining technologies for application in contemporary fashion garments.

The majority of literature suggested that each step of the design process must be re-considered to use these construction techniques for garments. Findings from the literature therefore stressed the need for technical knowhow of these fabric joining technologies to underpin the design process. The results from this study concurred with these findings, indicating that only once a very clear understanding was established of how the constraints of the construction technology can affect each stage of the design and development of the garments; was it possible to generate design solutions.

Previous studies associated with using the pattern making process as a means of design, revealed that this can provide an opportunity for incorporation of the more technical aspects of garment manufacture into the design process. Their findings demonstrated that a 3D design methodology allowed for considerations such as cloth usage and manufacturing processes to be built into the design process. The 3D design methodology developed for this study allowed for the capabilities of the construction method to dictate the design approaches in all areas of garment development. Taking a holistic approach to the design of the garments was found to yield new design aesthetics, which incorporate fabric joining technologies.

The literature identified a number of barriers to wider adoption of these manufacturing technologies in clothing markets. Costly production methods and the cost implication of introducing a new technology manufacturing technology in terms of training and machinery were cited as key factors. This research revealed that some of these factors could be taken into account when designing garments, if minimal fabric consumption and simplicity of manufacture are core design principles.

Findings from the industry feedback revealed that the benefits offered by bonding as a construction technology in terms simplicity of manufacture compared to

sewing can only benefit manufacturing in the long term as there is still a requirement to develop skilled labour and invest in machinery.

Conclusions

Chapter 4 Conclusions

4.1 Introduction

This chapter concludes the thesis, to consider whether the initial aim and objectives of the study have been met and whether this research can be used to identify potential avenues for further research.

This thesis presents the findings from a practice-based study, which uses a design enquiry to adapt approaches to pattern making to consider new fabric joining technologies for contemporary fashion. Previous research has used some methods of welding to construct garments and consider how their design needs to be adapted to suit this construction method. This research however, is the first to consider how a wider range of joining technologies can be approached through design for application in fashion garments.

4.2 Research objectives: summary of findings and conclusions

In order to establish whether the overall aim of the study has been achieved successfully, each of the research objectives will be revisited in turn, and the findings from each will be summarised to draw conclusions.

4.2.1 New joining technologies and their applications.

The process of identifying and testing joining technologies revealed that the parameters involved for each method of heat, pressure and time, require very careful control and must be adapted to suit the particular application. As indicated by a number of studies, findings from seam testing showed that some welding methods produced unsuitable seam strengths for clothing construction. As previous studies had identified that bonding can offer superior seam strength to stitching, this proved to be a suitable solution. Once tested however and through examination of joining applications in clothing, it was clear that the method presented a number of considerations for the design of garment shapes. Wider issues associated with manufacturing with bonding were also identified, describing the machinery as costly and slow. Trade journals, which detailed the use of joining technologies in clothing manufacture, also identified that these construction

methods can present a number of particular constraints for the design process. In order to incorporate such constructions, it was revealed that the whole product needs to be re-designed. Further issues that were revealed related to the barriers to wider adoption of joining technologies as a method of manufacture across the wider clothing market. Investment in training and machinery were cited as reasons for this issue. Technological advantages over sewing are presented by a number of these joining methods and claims that they can simplify sewn construction methods was found to be a potential opportunity, which could be exploited through the design process to mitigate against costly production.

As traditional sewing methods have long been established in clothing production, it is understandable that a new construction technology that requires significant investment from manufacturers and brands currently has limited use. The technical training and support required related to machinery alone presents a barrier for manufacturers. These factors would add significant cost and therefore restrict products to the higher, more costly end of the market. The method must be an attractive option for brands, to support this growth in manufacturing but as using such methods of construction has ramifications on the garment design and development processes it presents problems for both parties. If each product needs to be re-designed to consider the technical requirements of the construction then understanding the benefits they can bring to garments must be the key to wider adoption.

4.2.2 Methods of shape generation for new joining technologies.

The findings from the first part of the research indicated that the technical requirements of the joining method, suitable for use in clothing would place restrictions on the design process both in terms of its technical understanding and in terms of applicable garment shapes. Once shape approaches were identified that were compliant with the requirements of the bonding technology it was possible to explore design methodologies which could incorporate how the construction method dictates all elements of the garment's design. Practitioners who had used the pattern making process as a means of design, had successfully implemented construction and manufacturing considerations into the design process. The potential to build the requirements of the joining technologies into every step of the design process offered a potential solution to generate design

solutions. Zero-waste and minimal manufacturing strategies had been implemented in previous studies by a process of designing with patterns. The shape approach selected to complement the joining technology provided clear examples of garments displaying these same principles. Following these same strategies in the design practice: to eliminate cloth waste and simplify production processes had the potential to mitigate against the wider manufacturing issues. The design brief that developed was to produce garments that work around the constraints of the technology, simplify production and leave no cloth waste.

The need for a new approach to shape, which considers the constraints of the technology, begins to reveal the adaptations that may be needed to the traditional design process, in order to implement these new means of construction into garment design. The literature stated that every element of a garment's design would need to be adapted to suit the joining technology's capabilities. To execute this stage of the design process, the researcher took on a design and technical role to consider aesthetic design and technical execution. To account for this in an industrial setting would require specific specialist training for technical and design staff. It is important to consider what the wider implications would be for training and education in terms of the costs and time associated with developing appropriate skill bases in industry.

4.2.3. Applying an experimental holistic design approach.

The process of design evolved throughout the practice. Design possibilities were generated early on, but as there were many design stipulations, viable design solutions were only produced once a solid foundation had been established. The overall message from the literature was to let the technical understanding of the joining technologies underpin every stage of the garment design process. Only once knowledge had been acquired from sampling on the machines and suitable shapes had been selected and tested; could the process of designing begin. The constraints of the joining technologies dictated every decision made in the design process from fabric, construction, pattern shape and design. A sound technical understanding allowed for ideas to be generated, and the process of designing 3-dimensionally, creating patterns at the same time as planning the construction meant that technical considerations could be factored into this design process.

The findings from the practice which, is central to this study demonstrates that technical knowledge of joining technologies underpins the design process. The process of the design practice, which evolved in the research, reveals that a completely new approach to garment design and development is needed to incorporate welding and bonding technologies. The results of this study demonstrates that a more technical design method is the key to further understanding how joining technologies can be applied to garment design. A holistic design approach is required that is rooted in an understanding of the technical capabilities and constraints of the joining technologies.

The outcomes created for this study reveal that it is possible to consider some of the wider issues of using these joining technologies when designing and constructing garments. Opportunities to reduce fabric usage and manufacturing processes were implemented through a 3D design approach, complemented by the benefits of the construction methods. This process however, was only possible by developing and creating a whole new design methodology underpinned by technical knowledge.

4.2.4 Evaluation of the outcomes: industry feedback.

The industry feedback provided some positive outcomes, the garments presented new aesthetics, appreciated by the experts via their feedback. The experts agreed that the garments show how new joining technologies present new design possibilities for garment design. Considering some of the intentions behind the research however, it was noted that although the garments produced seek to exploit one of the benefits of bonding technologies through manufacturing efficiencies, this benefit may only be realised once companies have made an initial investment in labour and machinery. Therefore, the benefits of using this technology can only be realised in the long term.

Considering the wider industry implications related to this study, may indicate that the benefits claimed in the literature, which were explored through garment design, may not be as straightforward to realise in an industry setting. The joining technologies used to construct the garments for this study allowed for simplification of traditional sewn construction processes and it is clear that this can present benefits to clothing manufacturing. However, if the wider clothing industry and

specifically the contemporary fashion market is to embrace this as a new technology there has to be a clear benefit for adoption. If the desire for new design possibilities and a fresh aesthetic are strong enough from brands, factories may choose to invest in labour and machinery. Over time once this builds, the costs may come down.

This study has shown that designing with patterns provided an opportunity for the technical considerations associated with the construction technologies to be factored into the design process. A 3D design methodology developed which confirmed the need for a clear technical understanding of the joining technologies to inform every stage of the design process. Considering the wider issues which this study has raised, it is clear that new fabric joining technologies can bring new design and aesthetic possibilities to garments but require a complete shift in thinking. Traditional garment design, development and production roles would need to change radically in order to account for this new approach

4.3 Recommendations for further work.

The findings from this study have revealed a number of issues around adapting a design approach to consider joining technologies. Although the practice allowed for development of a design approach, which considered the capabilities of the joining technologies and produced design solutions, the study was not intended specifically for this purpose. More research would be needed therefore, to explore other methods of developing design approaches, which would allow for the design and development of garment with joining technologies. Recommendations for further research therefore, would be to explore alternative design approaches in order to develop a design framework to incorporate the joining technologies of welding and bonding into garments.

The project focused on design solutions to simplify production processes and endeavoured to mitigate against a costly, slow and not widely adopted manufacturing technology. As would be normal in an industrial setting, costings and sourcing issues were not considered, which would have determined pricing and in turn, customer needs and market level. This was not possible to consider in a study of this size, which focused on many other issues. Potential areas for further

research would therefore be to determine whether the manufacturing costings of joining technologies could present it as a viable manufacturing possibility method for the fashion market.

Promising results were generated during the course of the practice when testing the joining technologies and exploring the sampling process. As the process of testing evolved, a number of garment construction ideas were generated. Through the process of sampling, it was discovered that this was an effective way to produce construction ideas, which could then form the basis of design ideas. A further study could allow for development of further samples, which could act as a toolkit for designers to incorporate bonded and welded constructions into their design.

4.4 Reflection.

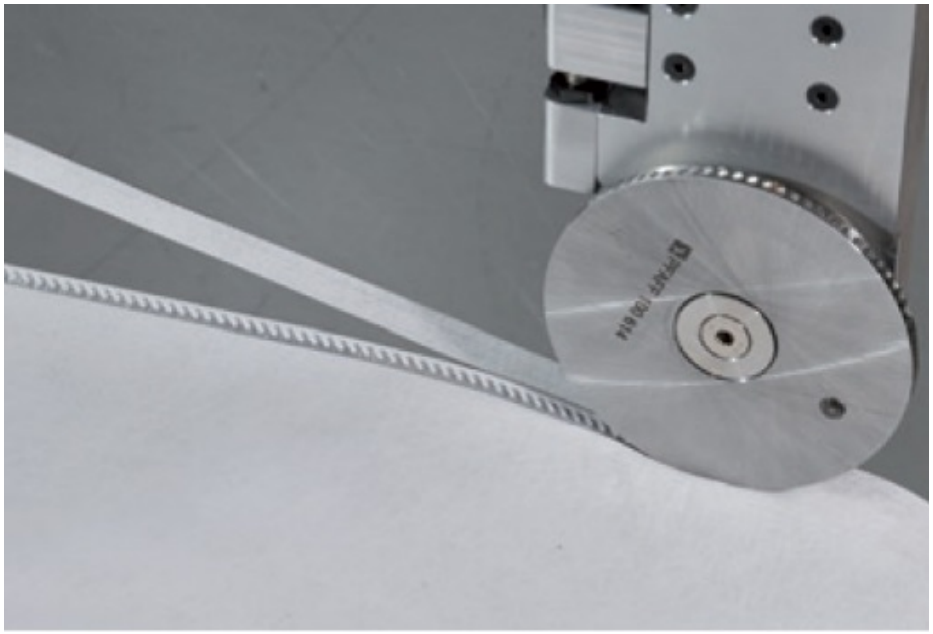
The research has produced promising outcomes, which display a new aesthetic and incorporate a consideration for manufacturing and cloth usage. The initial motivation for the research was taken from a design perspective, as it was clear to see that new fabric joining technologies can offer design possibilities, construction and pattern shapes not possible with sewing. Once the project was underway, even though the literature had stressed the need for technical understanding of the joining technologies, it was not until the late stages of the design process that this really became apparent. Rather than being a free and creative process, there were some very strict guidelines to follow, so design possibilities were few. In hindsight, perhaps the added stipulations of minimising cloth waste and simplifying production placed more barriers on the design process. Despite this, it is important to consider that in many ways, these imposed restrictions required one to be even more creative with the design solutions.

Appendices

Appendices

Appendix 1 - Welding types & visual examples

Ultrasonic welding (also called sonic welding)	
Process	• Uses ultrasonic / sound energy. • Electrical energy is converted into high-energy vibration by means of piezoelectric discs • Sound vibrations build up frictional heat at joining point, melting the fibres together.
Method	Plunge or continuous
Suitable fibres	70-100% thermoplastic fibre content
Fabrics	Woven, knitted, non-woven or film
Advantages	• Very fast process • Heat is generated at the seam join, so fibres are less likely to suffer degradation. • Is possible to cut & seam in one process • Low profile seams. • Seam can be formed, sealed, cut and decorated in one machine operation. • Short seams can be welded more quickly than bar tacks can be sewn. • Process is very efficient as electrical energy is converted into vibrations resulting in very little heat radiation. • Embossing and patterns are possible
Restrictions/ Disadvantages	• Strength of join is dependent upon fabric and seam design. • Some seam types can cause hardened, stiff joins in fabric. • Only suitable for fabrics with 70% or more synthetic content
Examples of clothing applications	• Lingerie • Bra edge sealing • Bra straps and attaching hook fastener. • Adding a decorative edge to bra cups



Ultrasonic cut & seal seam, http://www.pfaff-industrial.com Löffler ultrasonic welded seam,

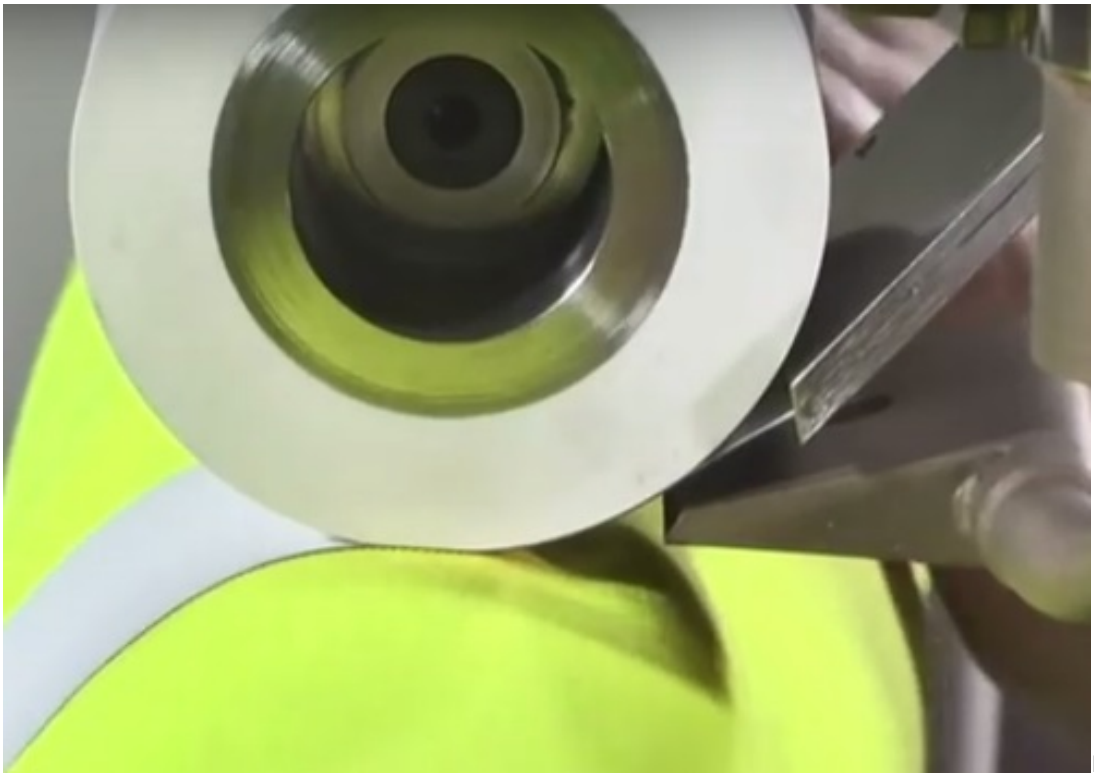
Löffler ultrasonic welded seam,

RF Welding (High frequency welding)	
Process	• Joins using dielectric heating • Fabrics to be joined are clamped between a die (also called an electrode) and metal plate. • A high frequency voltage is applied; the resulting electrical field causes a vibration in the molecules of the thermoplastics. • The fabric heats up and the die is pressed further down onto the surfaces, once cooled, a strong bond is formed.
Method	Plunge / stamp
Suitable fibres	TPU (Thermoplastic polyurethane), PVC (Polyvinyl chloride) EVA (Ethylene-vinyl acetate)**,** Polyester, nylon & modified PE (Polyethylene)
Fabrics	Woven, knitted, non-woven & film
Advantages	• Some machines can cut and join in one process
Restrictions	• Not compatible with fabric pieces that have been laser cut (due to the carbon residue left on the edges which reacts with the electrical process much in the same way as metal does in a microwave)
Examples of clothing applications	• Decorative motifs • Decorative trims • Rainwear

RF welding on clothing, Munari Materie Plastiche, http://www.munariplast.com

RF Welded Anorak 'PERTH' by Dolfing Druten, http://www.dolfing.org

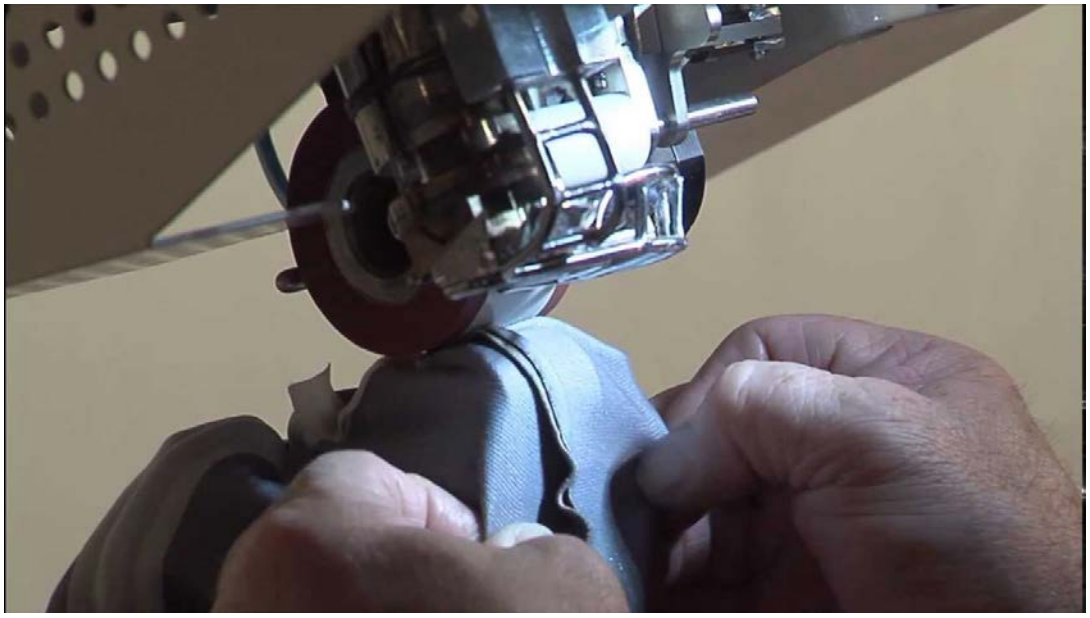
Hot wedge	
Process	• A small metal wedge delivers heat to fabric • It then passes between the drive wheels which apply pressure to the fabric and the material to be joined to seal the surfaces together
Method	Continuous / rotary
Suitable fibres	70-100% thermoplastic content
Fabrics	Woven, knitted, non-woven & film
Advantages	• Consumes less power and produces less noise than hot air welding. • Produces a durable thermoplastic joint. • Produces a sealed seam • Very fast process, cost-effective • Not as noisy as hot air • Low cost, consumables not needed e.g needles, adhesives, threads.
Restrictions	• Heat build if seaming process is interrupted, which can result in scorching of fabric. • Slower process than hot air welding • Not as strong seams as RF and ultrasonic • Restricted number of seam designs are possible
Examples of clothing applications	• Used to apply seam sealing tapes to sewn seams on waterproof clothing. • Lingerie & swimwear hems.

 Hot wedge application of reflective tape

Reflective tape applied to workwear by hot wedge hhangzhou-chinastars-reflective-material-co-ltd

Hot air	
Process	• Hot air is directed between the join surfaces • A roller or other tool then applies pressure to the join which forms once cooled.
Method	Continuous / rotary or plunge
Suitable fibres	70-100% thermoplastic content
Fabrics	Woven, knitted, non-woven & film
Advantages & benefits	• There is no contact between the heating element on machine and fabric, preventing scorch marks on fabric. • Very fast process (faster than hot wedge) • Cost –effective process due to speed.
Restrictions / limitations	• Not as strong seams as RF and ultrasonic • Hot air is noisy
Examples of clothing applications	• Typically used with PU (polyurethane) film tapes or films to seal sewn seams on waterproof clothing.

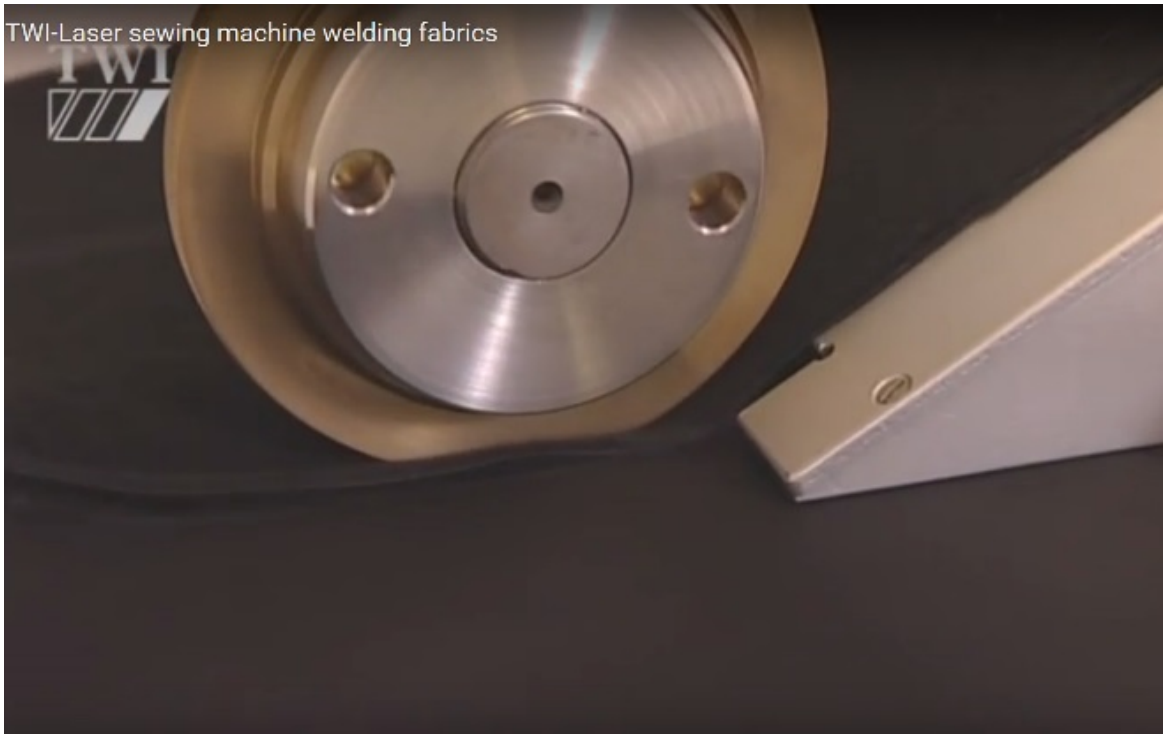
100% PU Polyurethane seam sealing tape www.stoffwindelei.de



Seam sealing tape applied on hot air welder

Sewn seams sealed with waterproof tape

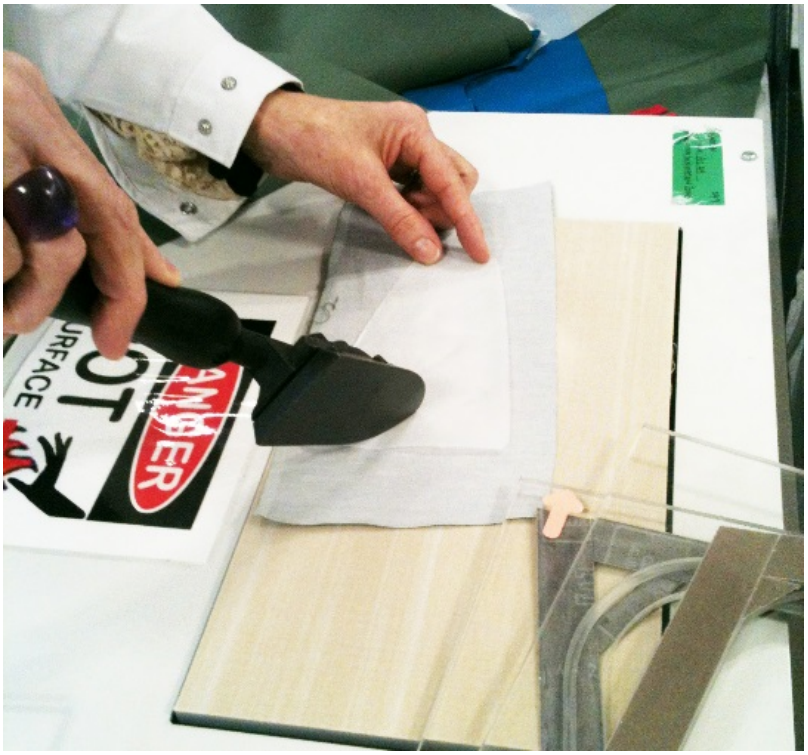
Laser welding	
Process	• A well-controlled amount of heat is directed at the joint surfaces. • The laser energy passes through the fabric producing heat, melting the fibres, once cooled a weld is generated at the joining points.
Method	• Continuous / rotary
Suitable fibres	70-100% thermoplastic content
Fabrics	Woven, knitted, non-woven & film.
Advantages & benefits	• Seals seams • Curved seams are possible • Welding can be achieved through several layers of fabric at once.
Restrictions / limitations	• May need to use an additional solvents such as Clearweld to convert the laser to heat and facilitate the joining process.
Examples of clothing applications	• Outdoor/ waterproof clothing



Laser welding a seam

Appendix 2 - Bonding machinery

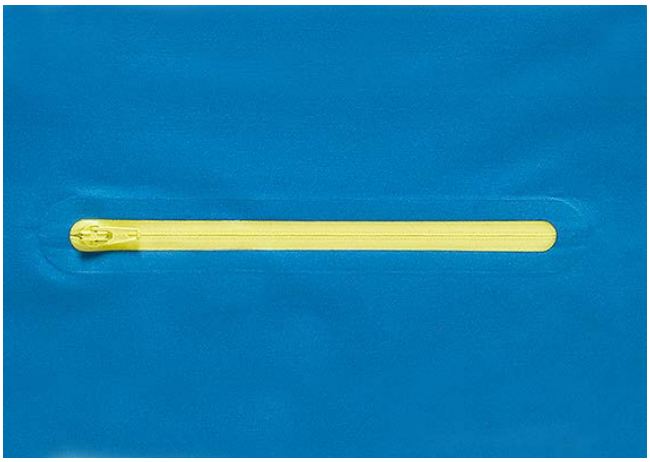
Utility table for pre-bond tacking	
Machine	 *Ardmel Utility table*
Description	• Heat spot bonding device & table. • Spot bonder allows for pre-tacking in bonding processes. • Bonder is smoothed across surfaces to be bonded to keep in place prior to the use of a bonding process such as a pneumatic heat press.
Applications	• Pre-tacking of bonding tapes, films, bonded seams, zips and other bonded accessories.



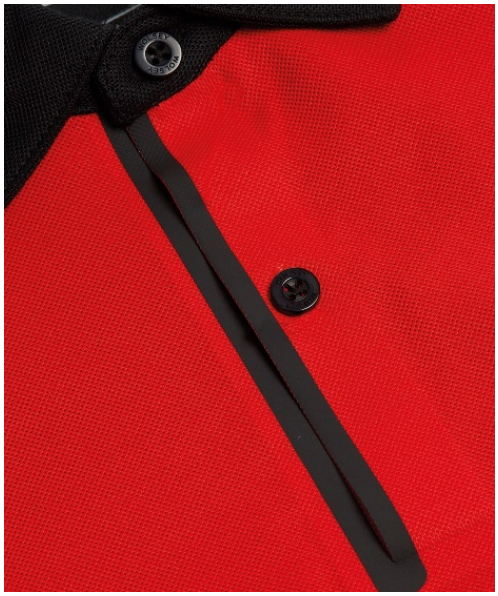
Pre-tacking preparation of bonding surfaces, E.Etheridge, 2013

Pneumatic high pressure bonding press	
Machine	 *Ardmel HSP-500 pneumatic high pressure bonding press.*
Description	• Bonding press with a plate size of 38cm x 20cm • Different plate sizes available according to application. • Adjustable heat settings for upper and lower plates. • Adjustable timer settings for bonding time. • Pneumatic function to ensure sufficient pressure between plates. • Bonding presses available with custom made plates to accommodate accessories such as zips
Applications	• Used to attach pre-bonded zips, pockets, tapes and bonding films and motifs to small areas of garment.

Eclat factory heat pressing bonded zips onto pockets



Bonded zip,www.bemisworldwide.com/industries



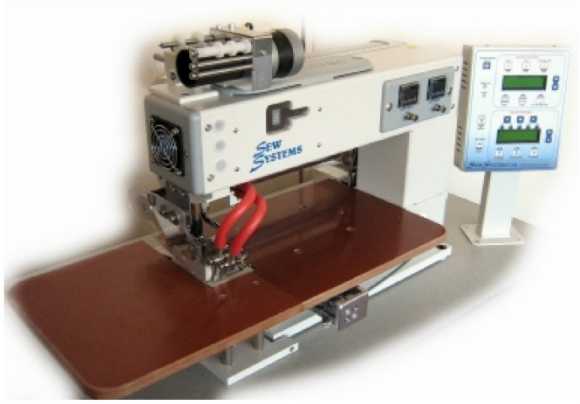
Wolsey pique polo with bonding film on placket opening

Lay down bonding machine	
Machine	 *Sew Systems AT800K bonding machine.*
Description	• Used in conjunction with a bonding machine for laying down bonding film prior to seam or hem formation. • For use with adhesive tape with release paper. • Adjustable temperature settings • Tape is fed through machine and heated between rotating plates to activate adhesive. • Rollers press the heated tape onto the fabric. • Optional cutting blade trims the excess fabric up to the tape. • An optional hot air blower can aid bonding. • The tape is applied to the edge of a seam prior to bonding to form a seam or hem edge. • Release paper is removed so edge can be bonded using a bonding machine.
Applications	• Hemming edges of lingerie & swimwear

Lay down bonding strips on hem edges of briefs,

Bonding adhesive tape with release paper, E. Etheridge 2016

Uniqlo laser cut briefs with bonded front seams

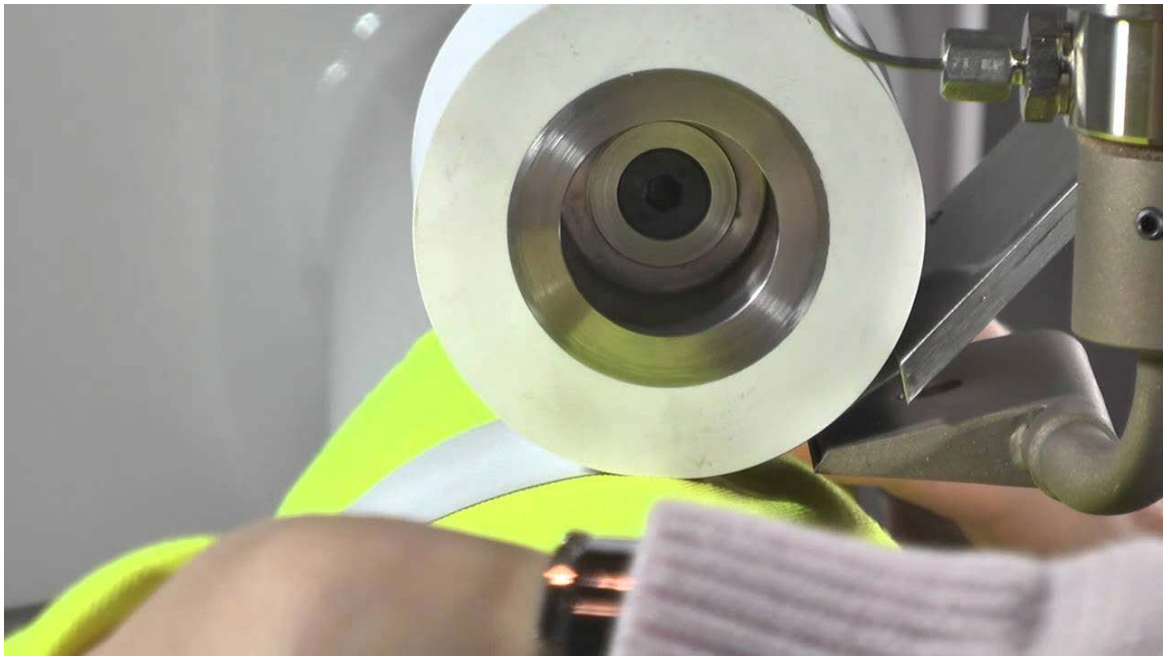
Bonding machine	
Machine	 *Sewsystems AT750LAM Long Arm Bonding Machine*
Description	• Flatbed bonding machine • 6 separate heated areas with temperature control, including hot air from above and below bonding area. • Can be used after lay down bonding machine to hem or complete seam. • Can be used to apply seam tapes. • Seam or hem is fed through machine, seam area is heated, activating adhesive and pressure is applied by moving belts to ensure bond.
Applications	• Seam taping • Lap seams • Applying bonded elastic

Bonded shoulder seam on Nike 2008 Swift Suit,

Bonded seams, www.bemisworldwide.com

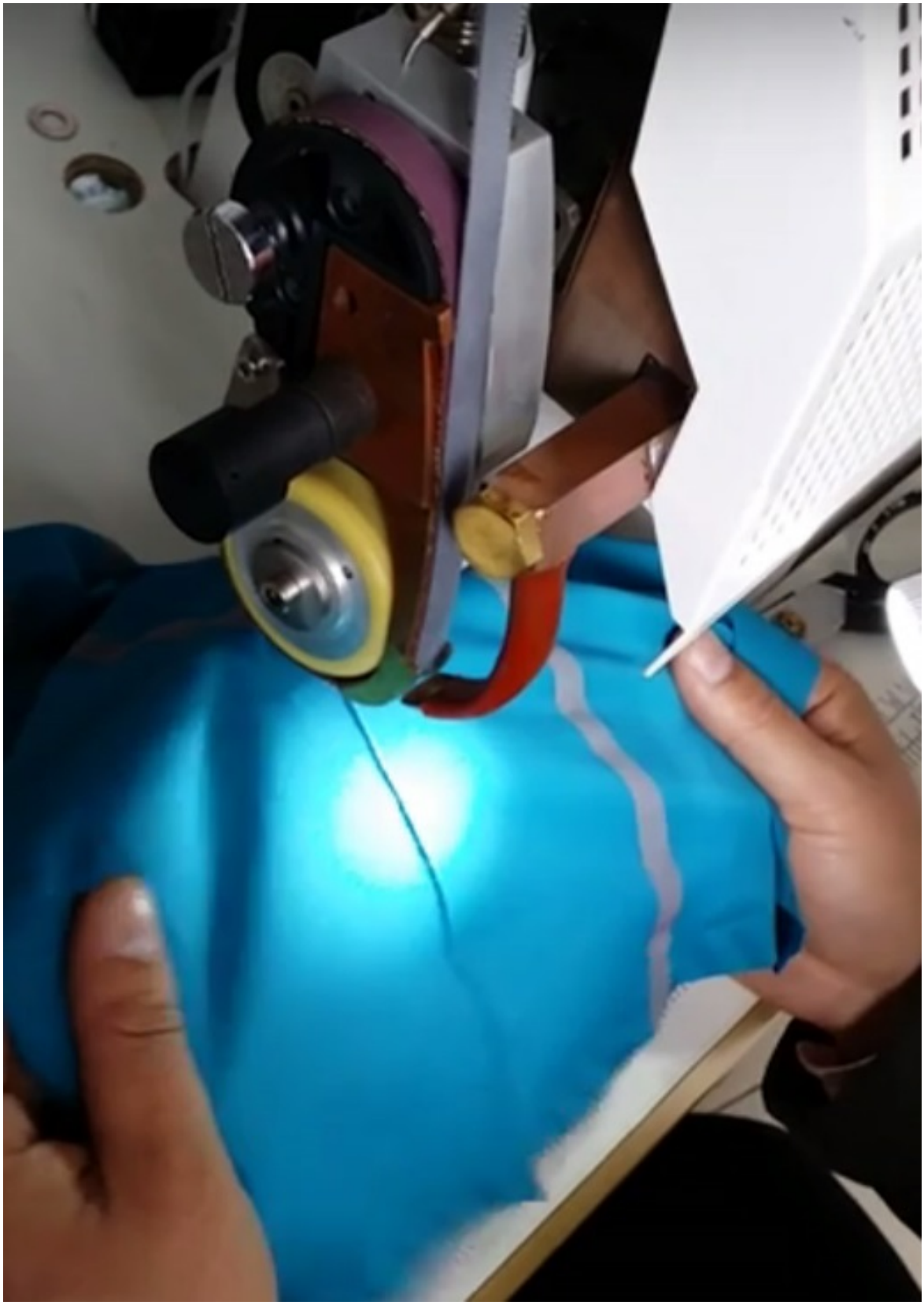
Bonded seam tape www.bemisworldwide.com/

Seam sealer	
Machine	 *Ardmel MK501 Seam Sealer*
Description	• Adjustable heat & speed settings. • Uses compressed hot air to direct heat at joining points. • Rubber rollers ensure pressure and flexibility on seam. • Used to apply seam-sealing tapes. • Automatic scissor tape cutting function. • Knee press feature to slow down machine for bulky areas of seam.
Applications	• Applying seam sealing tape on waterproof outerwear • For taping on underwear & sportswear.



Applying reflective tape to a garment,

Adhesive seam tapes



Seam tape application on welded seam,

Appendix 3 – Narrowing literature review of approaches to shape making throughout history of clothing in line with findings from literature on joining technologies.

STAGE 1 - Preliminary broad literature review of approaches to shape making throughout the history of clothing

Key text:	**Background**	**Theory/key insights**
(Alcega, 1979)Alcega, J. d. (1979) Tailor's pattern book, 1589. Bedford: Ruth Bean. **Introduction by:** Nevinson, J. L. (1979) 'Introduction ' In Pain, J., Nevinson, J. L. and Bainton, C. (eds.) Tailor's pattern book, 1589. Bedford: Ruth Bean,	Re-print of 16th century Alcega tailoring book with intro & translations by costume historian. First ever printed book on patterns/tailoring	'Book of geometry, practice and design.' From 13th century towns formed guilds to control cutting of men's clothing to protect their interests. Consider the book is not for training seems to be to provide instruction on how to cut out expensive cloth economically. printed1580 re-printed 1589 Some women's garments, no women's tailors men made their clothes.
Aldrich, W. (2007) 'History of sizing systems and ready-to-wear garments.' In Ashdown, S. (ed.) Sizing in clothing: developing effective sizing systems for ready-to-wear clothing. Manchester Woodhead Publishing,	Academic / fashion & pattern cutting practitioner	Mid-19th century RTW clothes available. Intro of sewing machine.Attributes it to standardisation of sizes. Systems of body sizes have to be linked to methods of pattern construction. Little evidence of systemised measurements applied to pattern drafts before 19th century. Before this individually tailored. Clothing the army/navy necessitated batches of similar / alike clothing 18th century wars Thinks adoption of standard units of measurements by tailors 19th century critical factor that generated the new ideas of applying measurements to theories of cutting. Creating standard smaller measurements (inch & cm) enabled tables of measurements and therefore drafting methods. Various tailors published/ argued merits of their method/theory. These were simple drafts, clothing for Napoleonic Wars 1803-15 necessitated more complicated drafting / grading methods. After this needed to dress the masses in formal wear e.g. banking etc. Developments in menswear market for standard sizing pre date developments for womenswear. By 1860 - 4 elements enabled RTW garments:**Standard units of measurements, practical theories of cutting, simple grading systems**

		(based on the new found theories of body proportions) and **emerging production technologies.** (sewing machine, band knife, steam press,)developments in textiles industries reduced the price of cloth. Proportionate system. Thinks style of women's clothing in the period prevented the development of RTW market as it was all very close fitting and required individual tailoring whereas menswear had ease of movement. Women-rich =tailored while ready-made patterns were available for dressmakers, who started to publish drafting methods some dressmakers had limited skill to adapt drafts/patterns. Paper pattern industry expansion by 1860 commercial pattern began to be available cut using proportional systems and graded by graduation. Method emerged from dressmaking. Making a basic bodice fitted to the client then adapting it for different types of garments. then became known as a block pattern .from this theory of creating size charts and applying them to drafts began to emerge. Mass customisation became the preferred method of fit emerged in US . Give some measurements and /out workers produce the garments, then factories set up. Most though were made from to proportionate pattern standards then few measurements altered creating an 'approximate' fit. End of 19th century in US clothing from mass production outstripped dressmakers. Volumes of garments made for anonymous bodies according to pre-determined sizes. Mass production of clothing advanced faster in US than Europe. Wholesale bespoke for men (the Burtons suit model) Factory production of clothing came in. Once a softer silhouette for women came in it enabled the RTW production to evolve. 1913 onwarsd. Sizing charts differed in how they measured the body under/over the coat, for women corseted body. Different sizing theories. First large anthropometric survey of women & kids 1939-1941 US/ became the model on which subsequent sizing surveys were conducted.
Arnold, J. (1985) Patterns of fashion: the cut and construction of clothes for men and women c1560-1620. c1560-1620. London: Macmillan.	Costume historian	Western Europe from 13th century tailors grouped into guilds to protect their interests. Mid-16th century foundations of cut & craft of tailoring had been laid. Earliest noted e.g. of women making clothes was in book from 1603, mention female tailor.

		Women began making clothes for their own sex end of 17th century. Tape measures invented early 19th century, first used strips of paper. Toiles used to fit clothes around 1575 used paper to take shape from toile in brown paper used to cut out fabric.
Boucher, F. o., b. . (1987) 20,000 years of fashion: the history of costume and personal adornment. Expanded ed, with a new chapter by Yvonne Deslandres. ed., New York: Harry N. Abrams.	Costume historian	Believes clothes are determined by climate/health/textile manufacture. Groups 10 millennia of costume into 5 archetypes Draped/slip on/closed sewn/open sewn/sheath costume . Modern times composite versions of these exist. Climate determines type of clothing BUT a number of factors affect the development according to nature of civilisation & their way of life. Agrees w Burnham that animal skin shapes were influential on later cutting practices. Loom weaving goes back to Paleolithic/Mesolithic. Solutrean introduction of eyed needle. First early clothing to 14th century not much change-long & loose
Burnham, D. K. (1973) Cut my cote. Toronto: Royal Ontario Museum.	Costume historian	Material from which garment is made has most influence on its shape. Pre-weaving areas where fur was normal for garments, subsequent garment shapes echo shape of animal skin even when cloth is introduced. Rectilinear form of cloth influences development of shapes of early garments. Following this theory, variation in looms and subsequent cloth width thus affects cutting practices in garments across cultures. Even when different/varied loom widths are introduced same cutting practices remain. Wide loom Greek and Roman draped. Examples of clothing types from across cultures with corresponding typical looms to support theory.
Castro, L. M. d. (2010) Patternmaking in fashion step by step. Köln: Evergreen.	Pattern cutting practitioner - Pattern cutting step by step book with introduction	Earliest book on dressmaking emerged in 16th century were more plans to aid cutting with little cloth waste. Use of patterns was frowned upon as a good tailor could transfer measurements to cloth. 19th century patterns in women's magazines with advice on fitting to the body. Intro. of sewing machine brought industrialisation & standardisation of therefore clothing sizes.
Debo, K. (2003) 'Patterns ' In Patronen. Ghent: Ludion,	Patterns book	Patterns from 16th century used to indicate how to cut out from cloth most economically (not to determine fit) Patterns a necessity for producing clothes on a larger scale=standardisation of clothing sizes followed as a logical consequence. Sizing systems developed with the objective of mass production with

		minimal economic loss. Standardization where a specific size can be worn by as many people as possible is essential if production costs to be kept down & to incorporate individuals needs into general demand.
Emery, J. S. (2014) *A history of the paper pattern industry: the home dressmaking fashion revolution.* London: Bloomsbury.	Clothing historian/history of patterns	Clothing began to reveal the shape of the body in the 12th century =cloth needed to be cut to form more complex forms requiring patterns to fit the body. Rock of eye method based on experience with patterns, shapes, garments. Means that a tailor can measure a client & mentally calculate their drafting formula drawing freehand on the cloth. From 1850 tailors sold full size patterns. From 19th century onwards a number of pattern drafting systems emerged- Proportional (standard body shape) Direct measurement - specific direct measurements. Most tailors used elements of both methods. Dr Wampden (drafting book) anthropometric / scientific system. 1880-1900 blocks/slopers used. Book Instructions for cutting out Apparel for the poor 1789 – earliest example of graded sizing.
Laver, J. (1996) Costume and fashion: a concise history, 2nd ed. De la Haye, A. (ed.) [Book] London: Thames & Hudson.	Costume historian	Arctic/tropical dress. Life on glaciers in Ice Age required warm clothes. Invention of eyed needle from animal bone meant hides could be sewn together to fit the body. Weaving required settled communities earliest examples were a simple drape of square/rectangle of cloth on shoulders or round waist. This type used by Egyptians/Assyrians/Greeks/Romans. Tailored clothes considered barbarian. Clothing shape unchanged for 3000 years. Crusades brought influence of the East/Orient to the West women began moulding gowns with buttons. Tunics still worn in Europe. From 1130 upper class women fitted clothes over bust & hips. 2nd half of 14th century changed clothing into fashion more fitted to body. From 1550 German domination of European fashion.
Milenovich, S. (2007) Kimonos. New York: Abrams.	Clothing / costume history Japanese kimono	Kimono remained relatively unchanged & worn in Japan until 1853 onwards to 1945 clothes changed to Western style with seasonal style changes.
Parker, M. S. (2003) The folkwear book of ethnic clothing: easy ways to sew & embellish fabulous garments	Historical costume designer/maker	Could be a lack of expertise in pattern cutting/to preserve cloth to explain why clothes are made from mainly squares rectangles these waste little cloth?

from around the world. New York: Lark.		Contests this historical evidence shows civilisations considered fitted clothes barbaric. Some cultures thought these were unclean as sewn with animal bone. Even when some garments don't waste cloth, they still use lots of cloth so not economy. Weaving & fabric made from human hands had spiritual integrity so cutting would decrease this power so cutting of cloth for garments kept to a minimum. Wide looms = draped shapes. Narrow looms=cut and stitched back together to accommodate body. Common types of cuts used across the world in historical clothing, rectangle, pull over cloak, shift with sleeves, pant, full skirt, open coat, shirt with yoke, short vest.
Sorber, F. (2003) 'The Pattern: An overview.' In Verhelst, B. and Debo, K. (eds.) Patronen. Antwerp: Ludion, pp. 23-32.	Book to accompany exhibition centring on the pattern in fashion.	Most non-western cultures garments cut wide & individual fit is less important. Pattern a necessity for industrialisation of clothing manufacture. Full scale patterns from 1850 (from magazines) smaller scale from 16th century. Cuts that revealed the shape of the body evolved in 12th/13th century by belting/buttons/lacing. Sculpting shapes then developed so tailors had to develop new skills. Alcega's book. Old garments used as patterns to make new. Poorer people in Antwerp couldn't afford tailor (16th century)– tailors produced clothes cut to standard sizes. 18th century scientist concerned with classifications of the world. Pattern emerged as an aid to produce cheap clothing. Tailors would use yards stick and paper to measure clients. Good tailors no need for a pattern. Fashion mag's in 19th century aimed at women gave instructions how to make clothes for seamstresses & housewives. Small scale patterns in magazines (1830) full scale (1860) In 19th century focus on fit of garments as embroidery became less popular. Focus on well fitted simple garment for men in 1800s & spread to women 19th/20th centuries. Between 1850 & 1900 lots of 'scientific' measuring systems to create pattern in Europe/N America. Sewing machine used on larger scale from 1850s necessitated inventions to work in combination with this in the area of cutting, preparing and sewing fabrics. Firstly fit wasn't a preoccupation, as initially clothes were for working classes

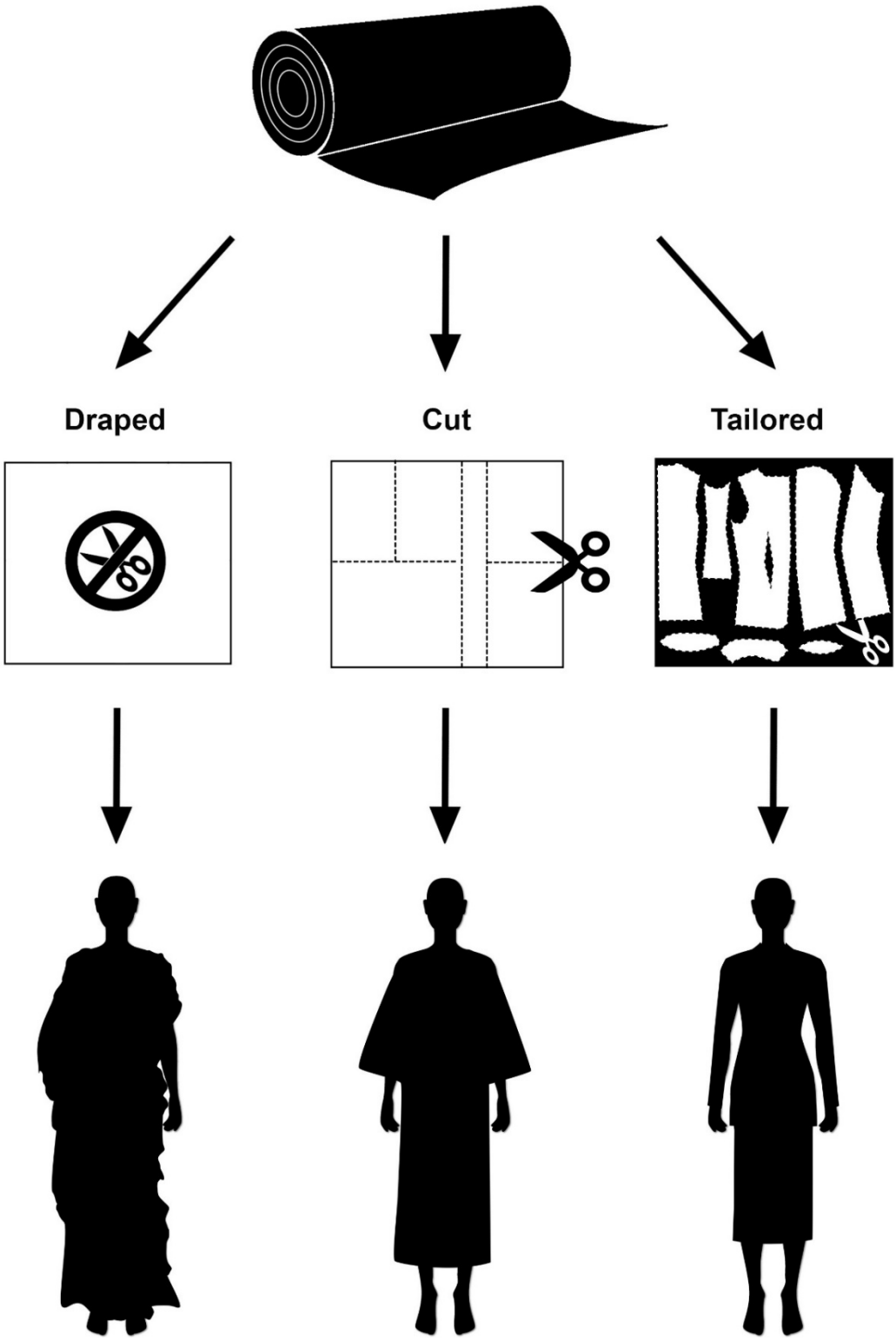
		or simple clothes that didn't need to be fitted like capes. Anthropometry has wide appeal on 19th century (classification) Sizing data to improve fit only evolved in 20th century (could enable people to buy clothes without trying on) Size USA 100,000 men demob from WW1 published in 1921? Mail order clothing established last quarter of 19th century needed sizing for this Other countries established standard sizes in 50s and 60s, ISO International Organization for Standardization from 1968 tried to introduce standard sizing published in 1991 but not widely adopted.
Tiramani, J., Davis, R., North, S. and Robins, P. (2011) Seventeenth-century women's dress patterns. Book one. London: V&A.	Costume designer	From the late 13th century tailors gathered in guilds no women, rules & conditions for apprentices. 17th century tailors made clothes for men/women, plus kids. Seamstresses made clothes close to the body. Tailors used parchments strips to measure would cut a pattern or directly from cloth. In 17th century seamstresses cut squares/rectangles/triangles to make economic use of cloth pleating, darts & gathers. Patterns used if embroiderer involved.

STAGE 2 – Findings from preliminary literature review of approaches to shape making summarised into 3 main approaches around technology.

Approaches summarised into 3 main ways garment shape were created (from introduction of weaving)
1 DRAPED APPROACH Wrapping of length of cloth around the body. • Cloth remains uncut • Wearer wraps to determine individual fit preference. • e.g Sari, toga etc.
2 CUT APPROACH Minimal cutting of cloth or use of narrow widths. • Pattern pieces of simple squares/rectangles/triangles. • Could be narrow widths of cloth that are joined to form the garment • Minimal cutting of cloth • When cloth is cut full use is made of width i.e. no or minimal waste • Resulting garments are loose on the body • Wrapping / tying /belting garment to 'fit' body.
3 TAILORED APPROACH Cutting and sculpting the cloth to fit the form of the body • Body is measured in some way (individual or sized) • Cloth is cut and shaped towards contours of the body • Pattern pieces are shaped in order to follow form of the body. (tend to be more numerous/more specific shapes than cut approach)

THE FOLLOWING DIAGRAM REPRESENTS THESE 3 APPROACHES VISUALLY:

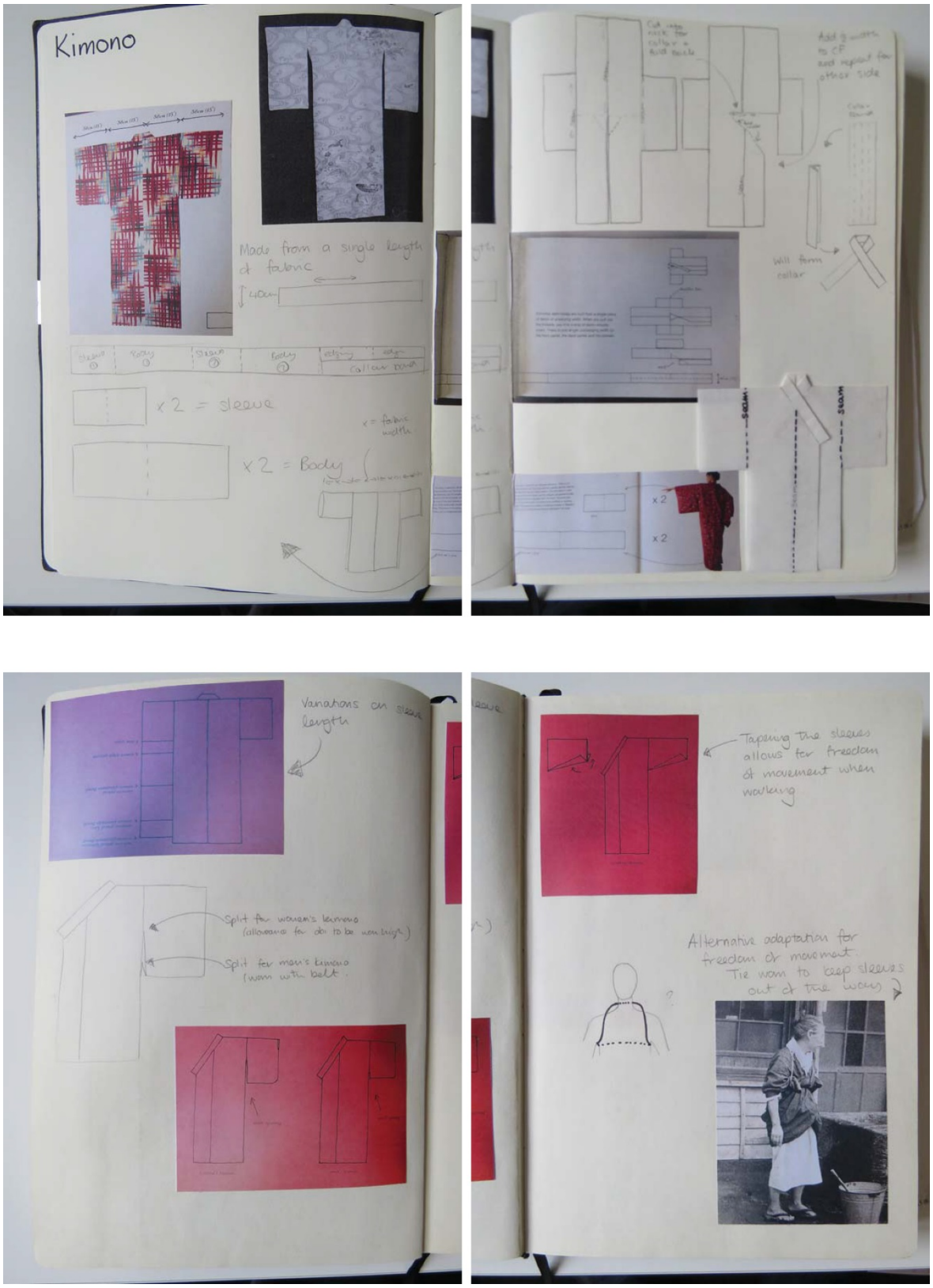
Approaches to garment shapes (Source: E.Etheridge, 2016)

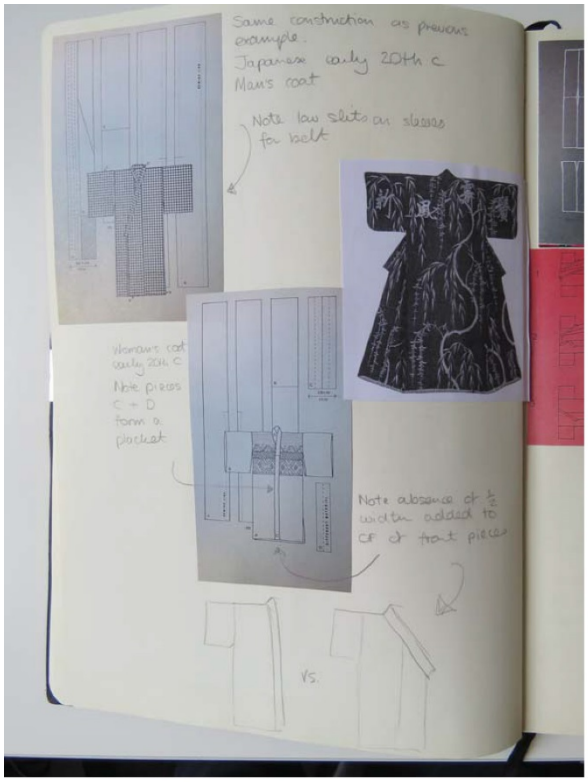


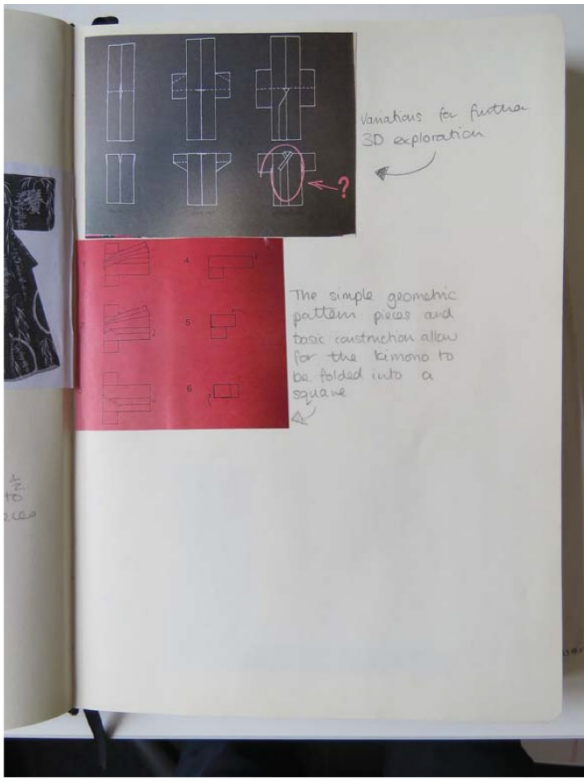
STAGE 3 – SELECTING AN APPROACH ACCORDING TO FINDINGS FROM JOINING TECHNOLOGIES LITERATURE REVIEW

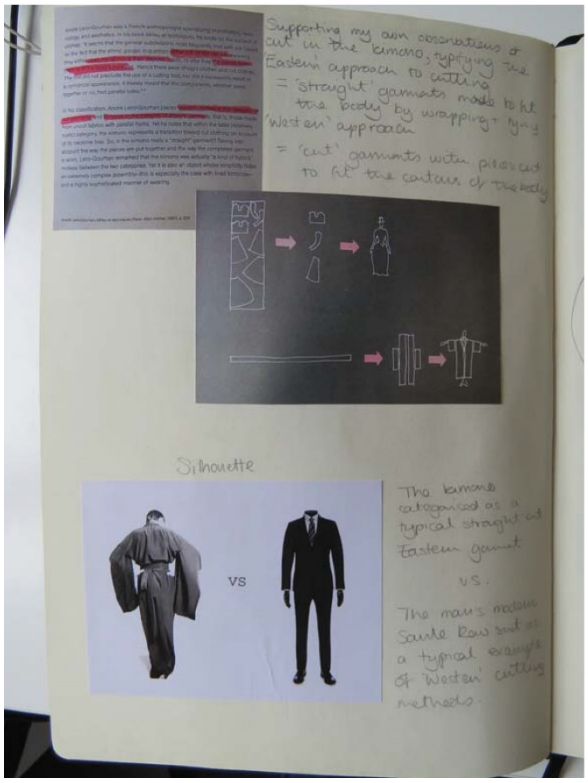
Insights from preliminary pattern cutting literature review that are applicable to findings from joining technologies induction and require further review and examination
Laver & Boucher both indicate that shape of early examples of clothing worn by man seem to be determined by climate. Burnham thinks it is less about climate and more about the tasks the wearer must perform in such garments suited to their work. Warmer climates require looser clothing. Colder climates necessitates cover the body. Therefore patterns / shapes / pattern making practices developed from these origins. Prior to loom weaving shapes of cuts echo forms of animal skins. Once weaving introduced (linear lengths) garment shapes follow this form. Again follows the climate theory wide looms Mediterranean =loose draped robes. Parker discusses loom widths and resulting shapes/forms of garments. Hand held / small looms result in narrow cloth and this needs to be sewn together to accommodate the body. Parker thinks resistance to sewing is respect for the weaver's craft, not lack of skill as there are prior examples of more complicated cutting. Then start to see examples of cloth being used in narrow widths, simple sheath on the body (climate) variations adding sleeves, coat shaped garments (for warmth) can observe/group these where **cloth is cut minimally** so garment **pattern is made of squares / rectangles** and **worn loosely on the body** tied at waist to 'fit' and some variations on this / layered up. Another theory is type of loom determined form of garment=as Mediterranean were v wide they could drape. Japan & Mexico, v narrow loom=narrow cloth so necessitated assembling pieces to fit body.
RELEVANT INSIGHTS FOR SELECTING APPROPRIATE PATTERN APPROACH TO USE WITH JOINING TECHNOLOGIES • Technology determining the form of the garment (Loom width theory) **JOINING TECHNOLOGY technical requirements are predetermining factor of shape approach to take?** Need to note findings from inductions seam testing to inform further literature review. • Minimal cutting to preserve cloth • Simple geometric cuts of cloth / dividing cloth to minimise waste. • Loose fit on body • Tying / belting to fit.

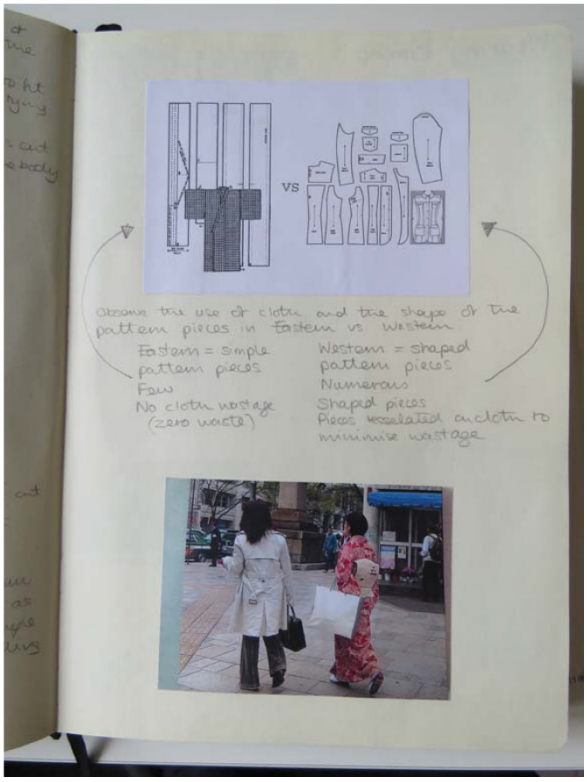
Appendix 4 - Examination of cutting practices using straight seams.

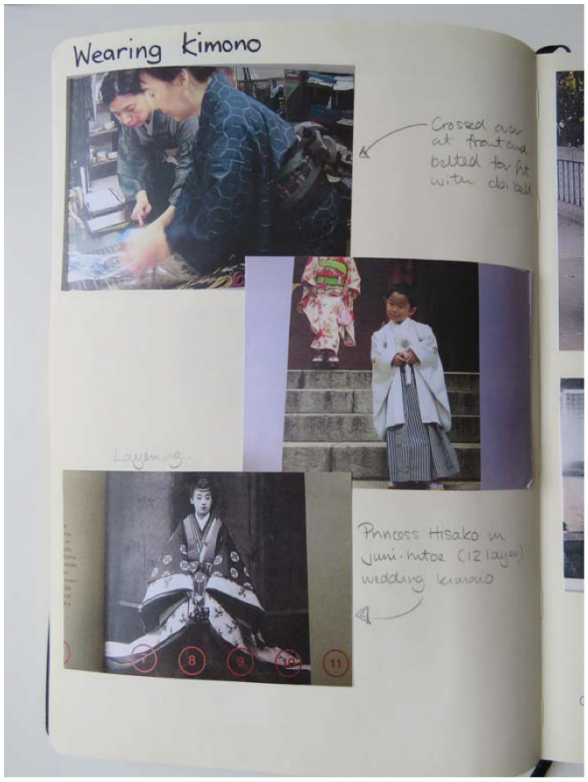


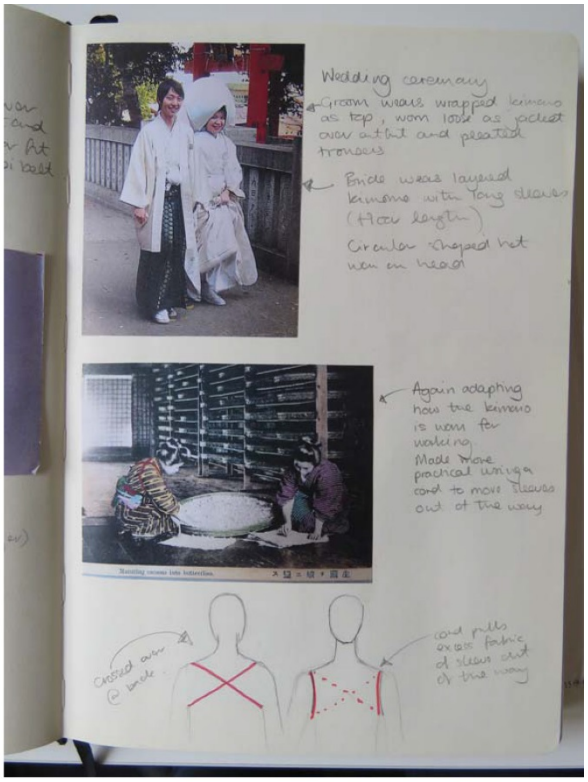

Same construction as previous example.
Japanese early 20th c
Man's coat
Note low slits on sleeves for belt
Woman's coat early 20th C
Note pieces C + D form a placket
Note absence of ½ width added to CF of front pieces
VS

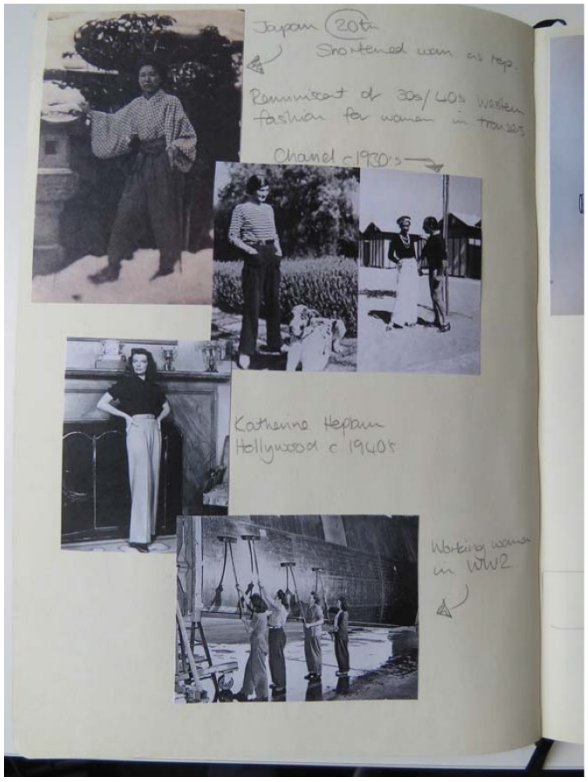

Variations for further 3D exploration
The simple geometric pattern pieces and basic construction allow for the kimono to be folded into a square

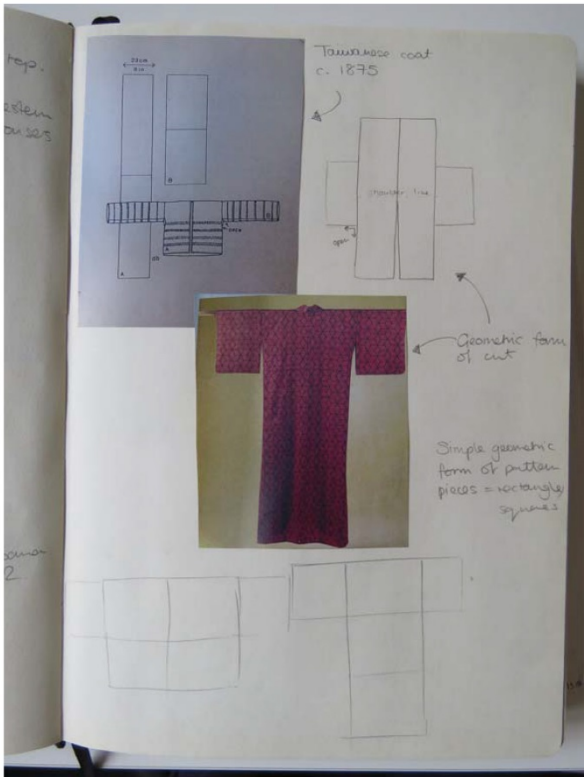

Supporting my own observations of cut in the kimono, typifying the Eastern approach to cutting
= 'straight' garments made to fit the body by wrapping + tying
'Western' approach
= 'cut' garments with pieces cut to fit the contours of the body
Silhouette
VS
The kimono categorised as a typical straight cut Eastern garment
V.S.
The man's modern Savile Row suit as a typical example of 'Western' cutting methods.

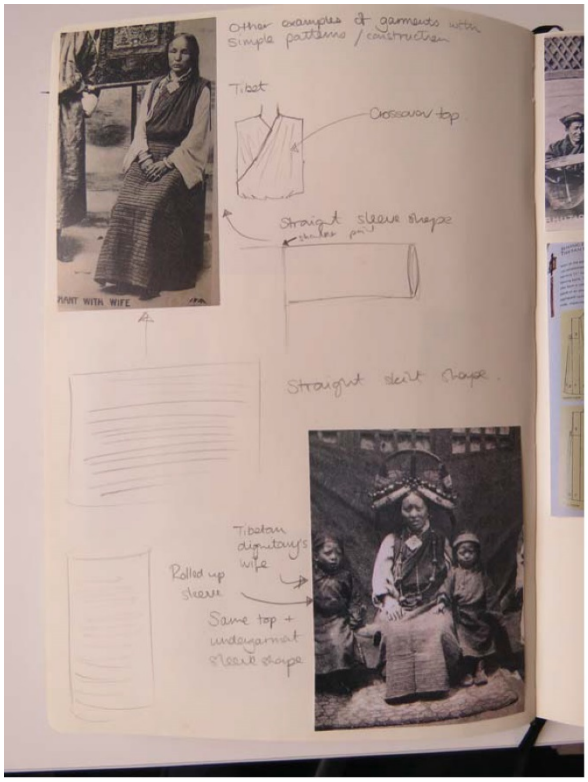

VS
Observe the use of cloth and the shape of the pattern pieces in Eastern vs Western
Eastern = simple pattern pieces
Few
No cloth wastage (zero waste)
Western = shaped pattern pieces
Numerous
Shaped pieces
Pieces tessellated on cloth to minimise wastage

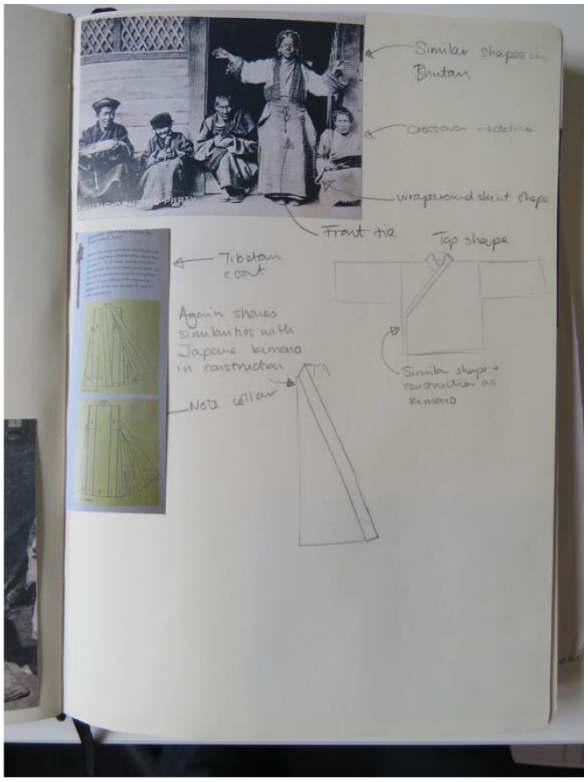

Wearing kimono
Crossed over at front and belted for fit with obi belt
Princess Hisako in juni-hitoe (12 layer) wedding kimono

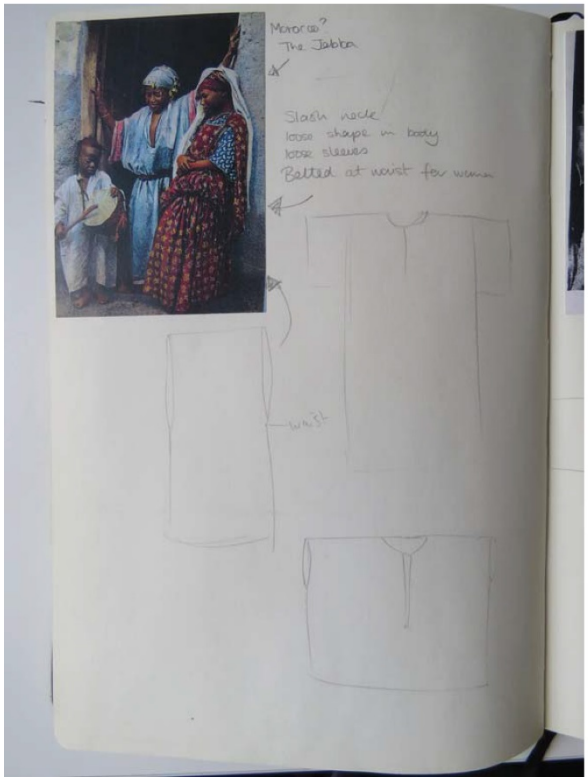

Wedding ceremony
Groom wears wrapped kimono as top, worn loose as jacket over shirt and pleated trousers
Bride wears layered kimono with long sleeves (floor length)
Circular shaped hat worn on head
Again adapting how the kimono is worn for working. Made more practical wrap a cord to move sleeves out of the way
Crossed over at back
cord pulls excess fabric of sleeve out of the way

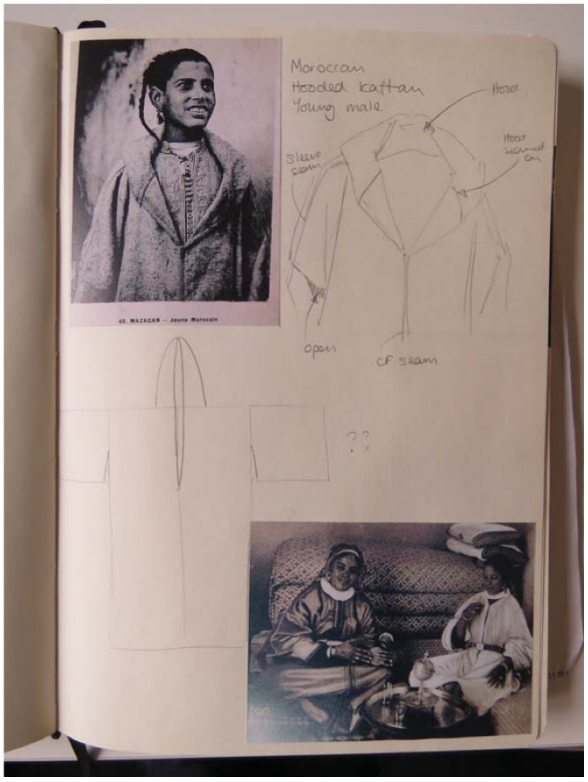

Japan (20th)
Shortened worn as top.
Reminiscent of 30s/40s western fashion for women in trousers
Chanel - 1930's
Katherine Hepburn Hollywood c 1940s
Working women in WW2

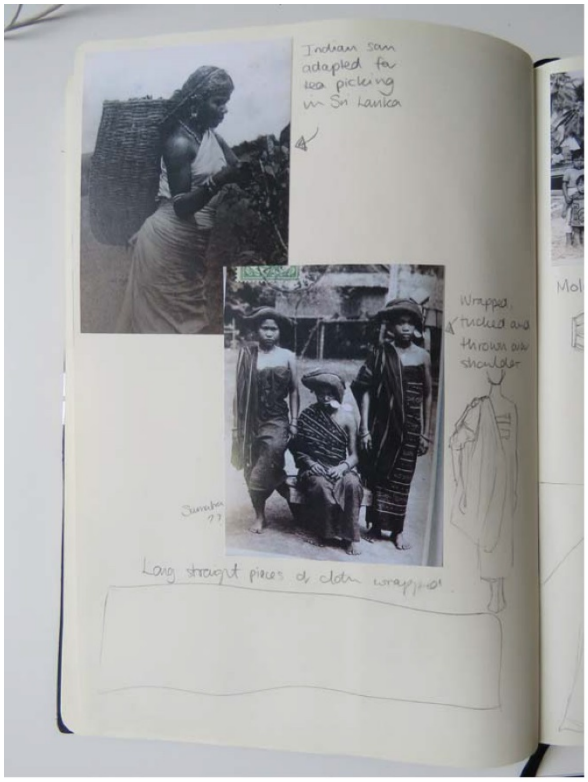

Tawaraso coat c. 1875
Geometric form of cut
Simple geometric form of pattern pieces = rectangles squares

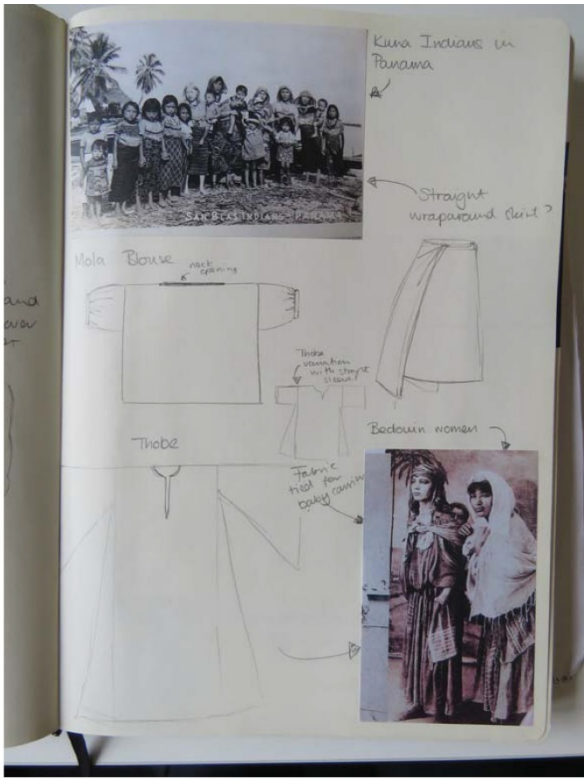

other examples of garments with simple patterns / construction
Tibet
Crossover top
Straight sleeve shape under arm
Straight skirt shape.
Tibetan dignitary's wife
Rolled up sleeve
Same top + undergarment sleeve shape

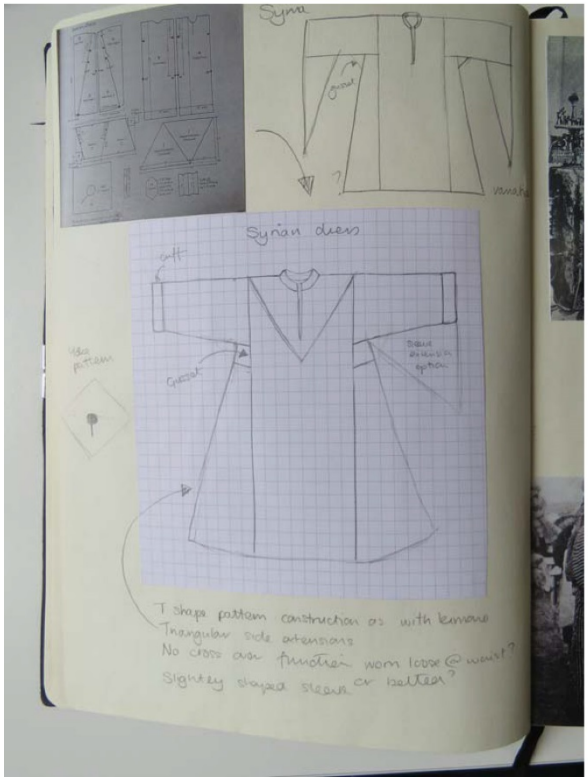

Similar shapes in Bhutan
crossover waistline
wrapround skirt shape
Front tie
Top shape
Tibetan coat
Again shows similarities with Japane kimono in construction
Neck collar
Similar shape + construction as kimono

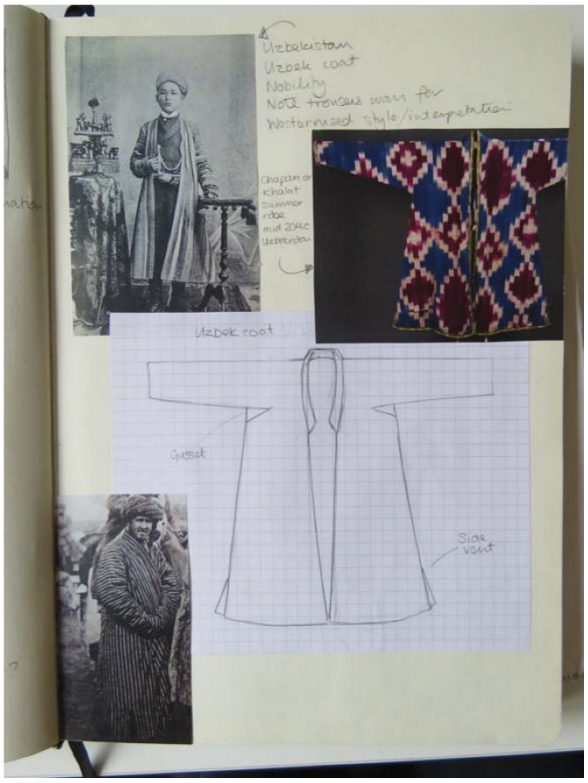

Morocco?
The Jabba
Slash neck
loose shape in body
loose sleeves
Belted at waist for women
waist

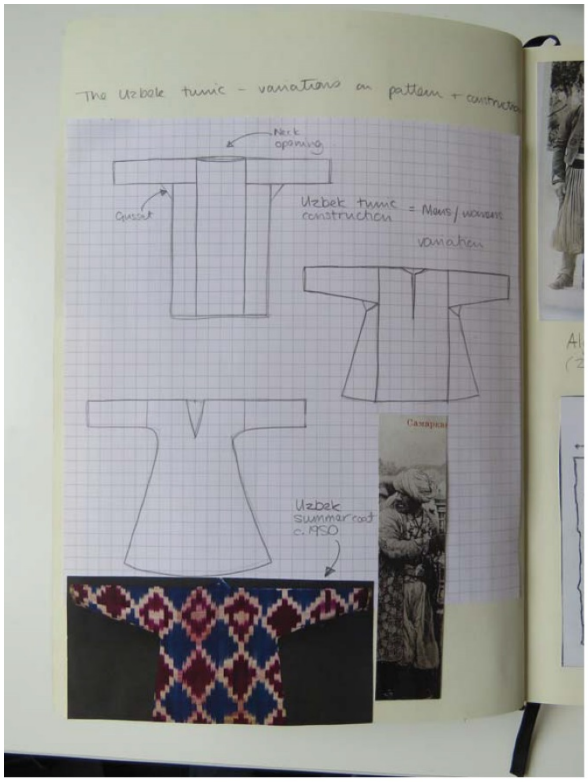

Moroccan
Hooded kaftan
Young male
Hood
Hood seamed on
Sleeve seam
open
CF seam
??

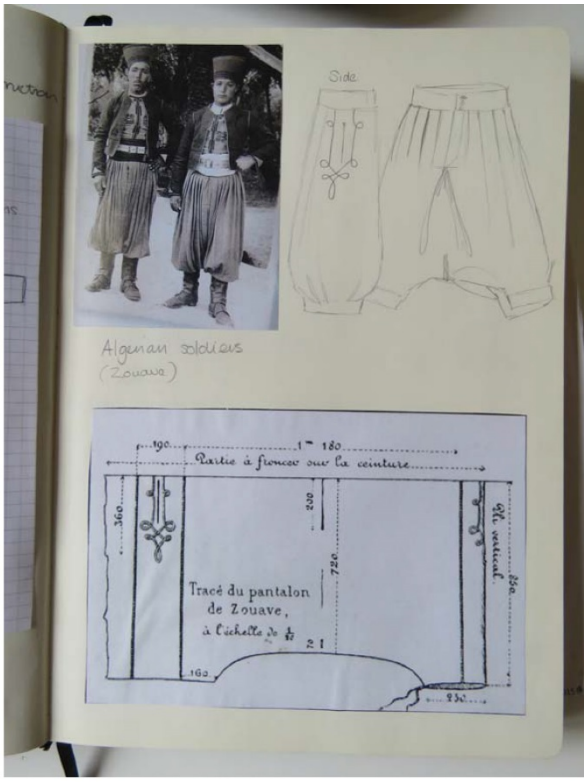

Indian sari adapted for tea picking in Sri Lanka
Wrapped, tucked and thrown over shoulder
Long straight pieces of cloth wrapped

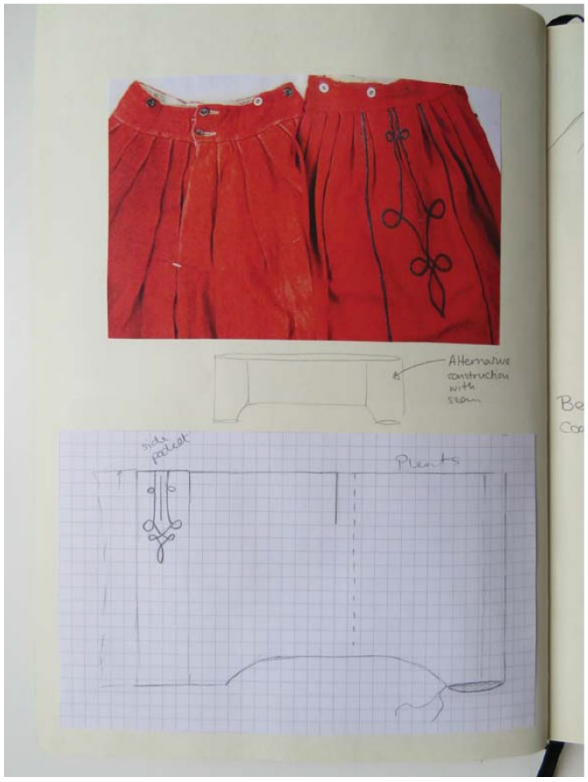

Kuna Indians in Panama
Straight wraparound skirt?
Mola Blouse
neck opening
Thobe
Bedouin women
Fabric used for baby carrier

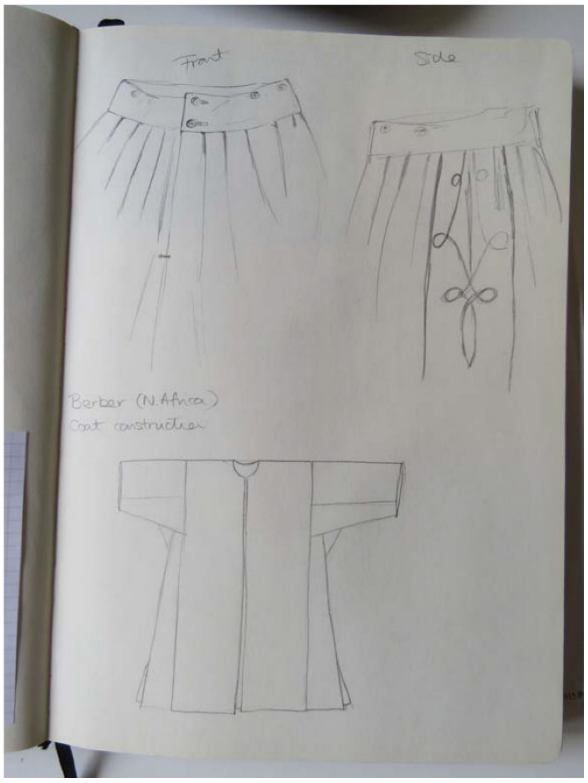

Syria
Syrian dress
gusset
T shape pattern construction as with kimono
Triangular side extensions
No cross over fronts/in worn loose @ waist?
Slightly shaped sleeve or batten?

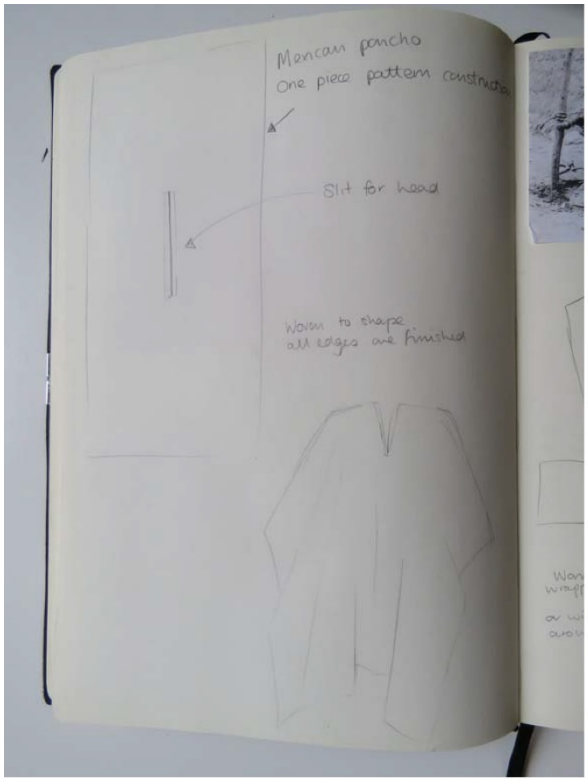

Uzbekistan
Uzbek coat
Nobility
Not trousers worn for
Westernized style/interpretation
Chapan or khalat
Uzbek coat
Gusset
Side vent

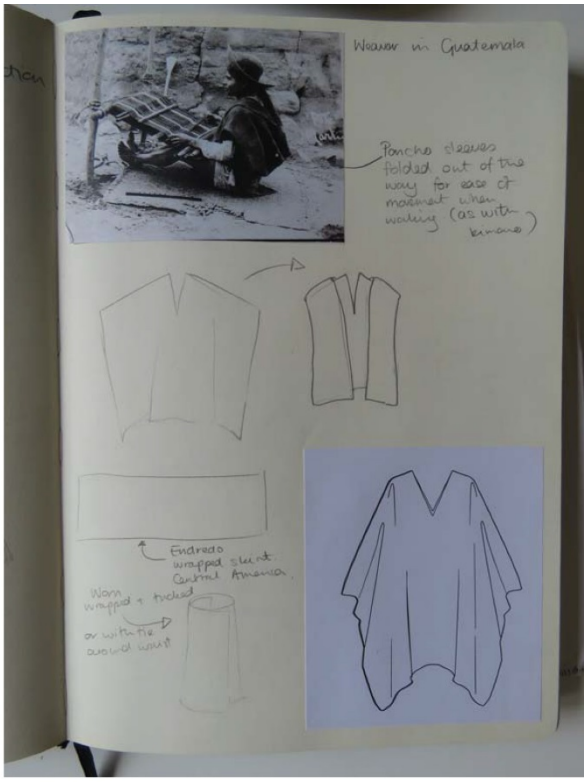

The Uzbek tunic - variations on pattern + construction
Neck opening
Gusset
Uzbek tunic construction = Mans / womens variation
Uzbek summer coat c. 1950

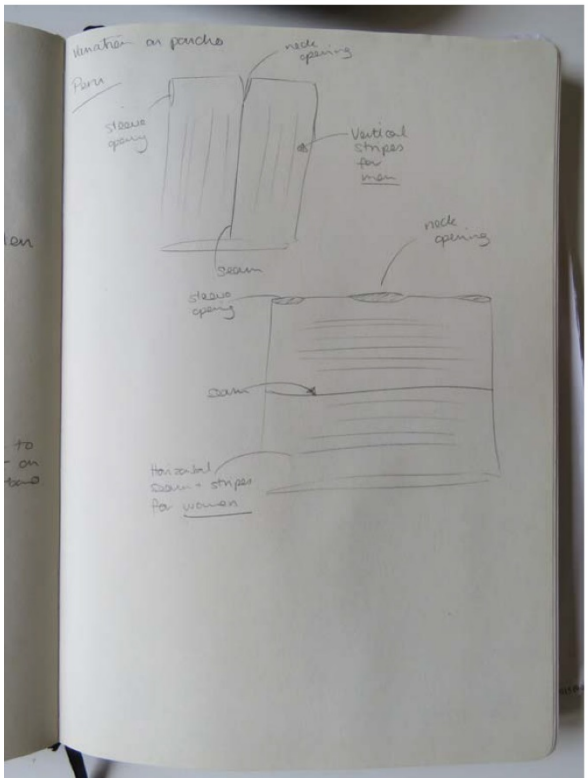

Side
Algerian soldiers (Zouave)
Partie à froncer sur la ceinture
Tracé du pantalon de Zouave, à l'échelle de 1/2

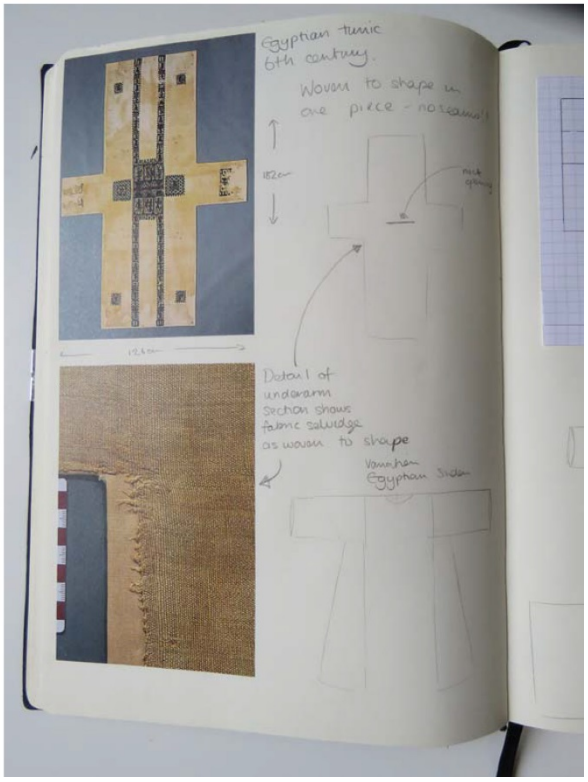

Alternative construction with seam
side gusset
Pleats

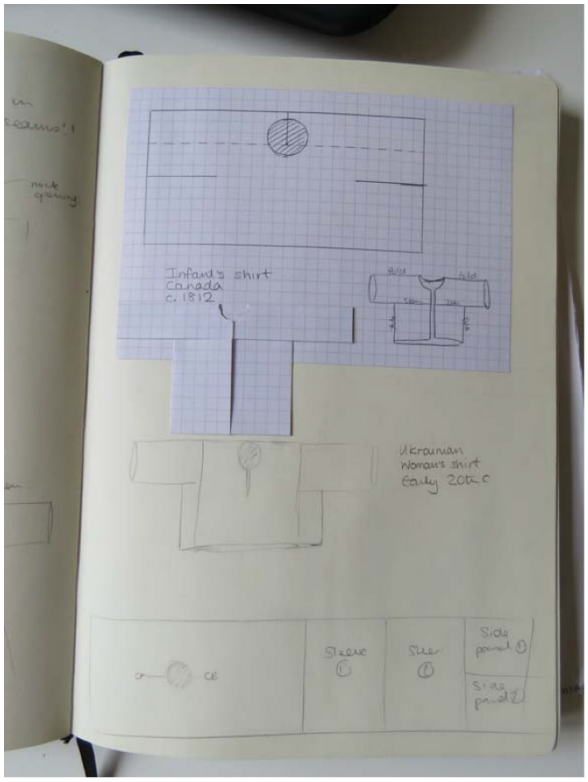

Front
Side
Berber (N. Africa) Coat construction

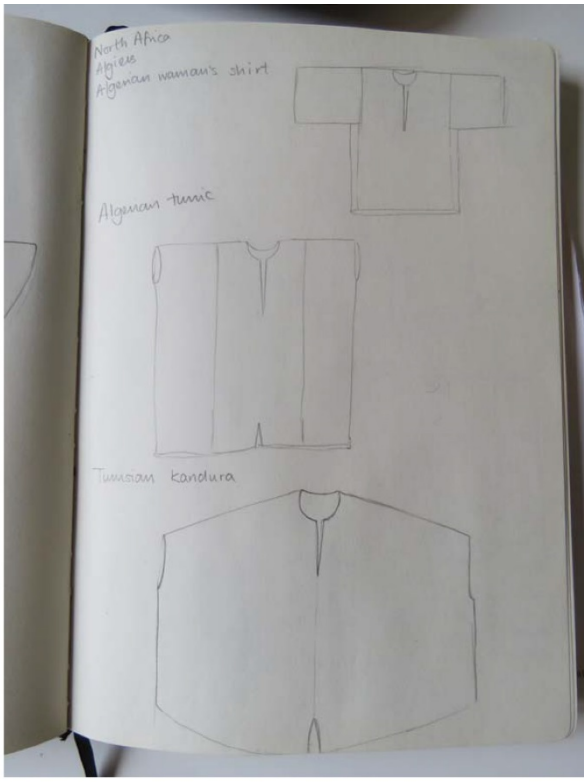

Mexican poncho
One piece pattern construction
Slit for head
Woven to shape
all edges are finished

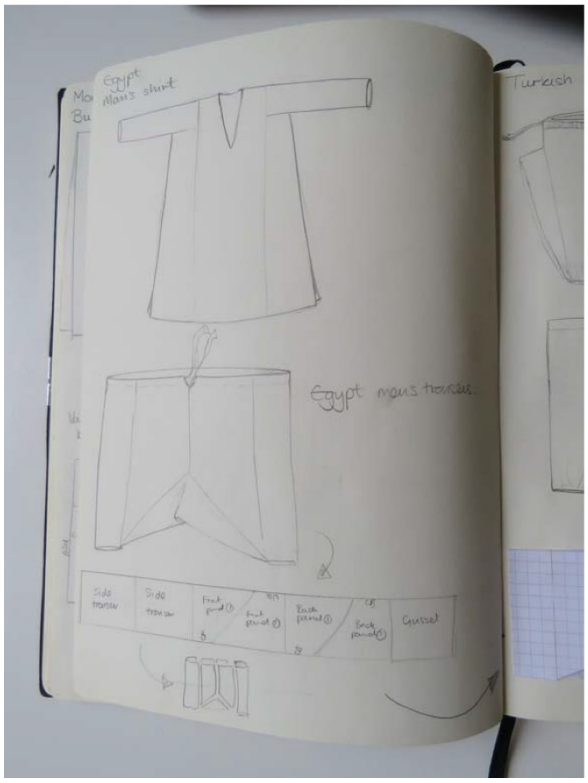

Weaver in Guatemala
Poncho sleeves folded out of the way for ease of movement when walking (as with kimono)
Endrezo wrapped skirt. Central America.
Worn wrapped + tucked
or with tie around waist

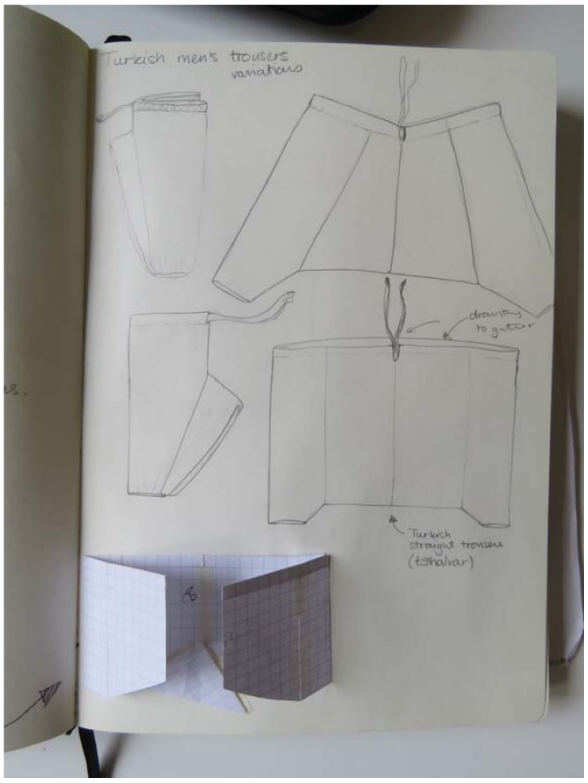

Huipil or poncho
Peru
neck opening
sleeve opening
Vertical stripes for man
seam
neck opening
sleeve opening
seam
Horizontal seam + stripes for women

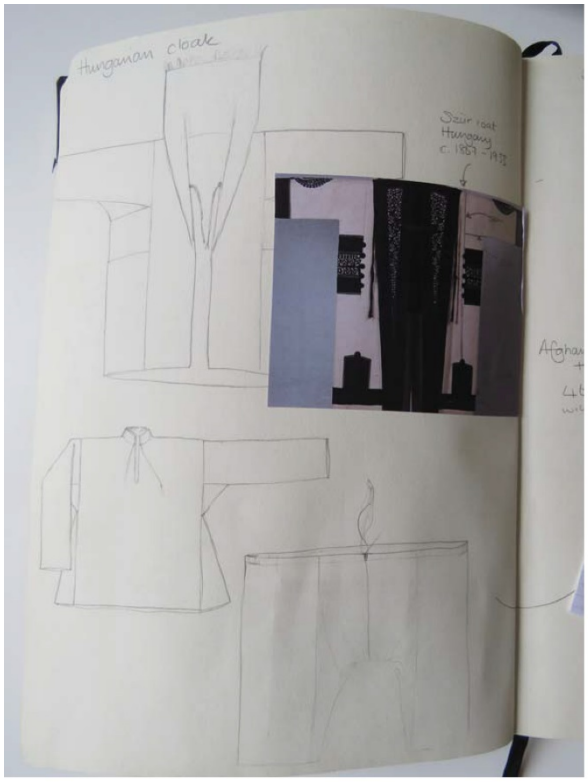

Egyptian tunic
6th century.
Woven to shape in one piece - no seams!
182cm
neck opening
Detail of underarm section shows fabric selvedge as woven to shape
Yamahan
Egyptian tunic

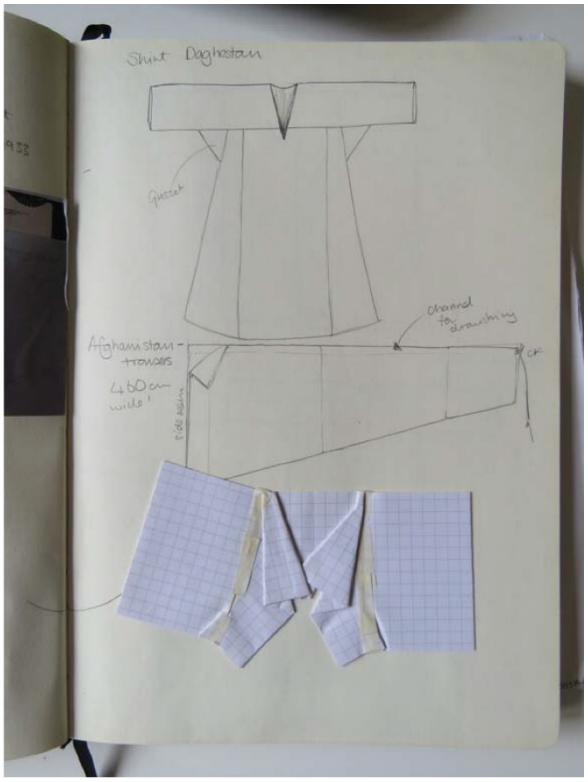

Infant's shirt
Canada
c. 1812
Ukrainian
Woman's shirt
Early 20th c
Sleeve
Side panel

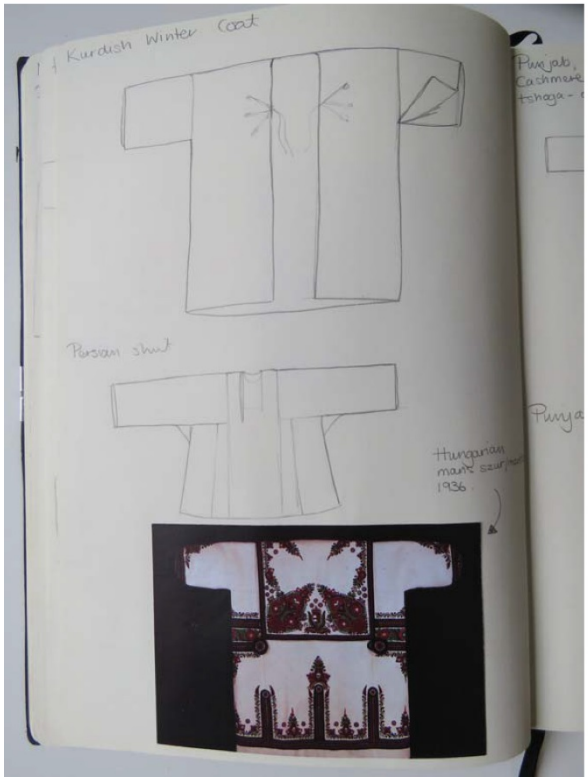

North Africa
Algiers
Algerian woman's shirt
Algerian tunic
Tunisian kandura


Egypt
Egypt mens trousers
Turkish
Side trouser
Side trouser
Gusset

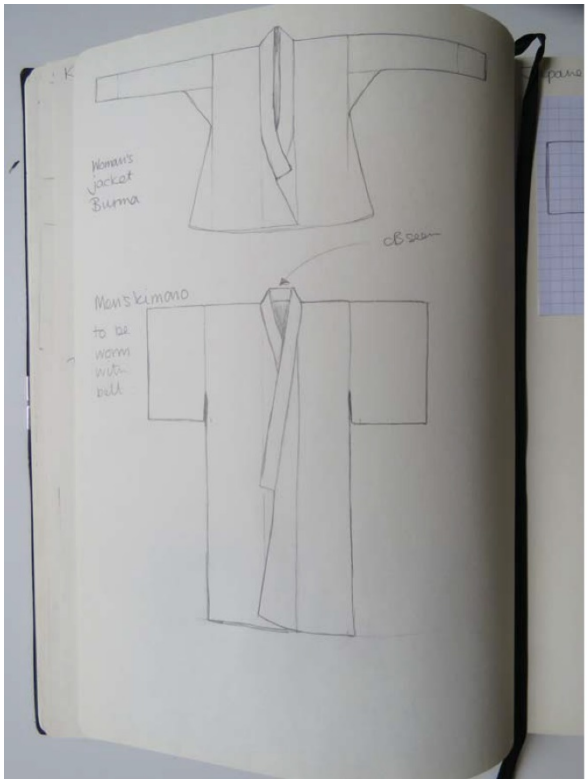

Turkish men's trousers
variations
drawstring
to gather
Turkish
straight trousers
(tshalvar)

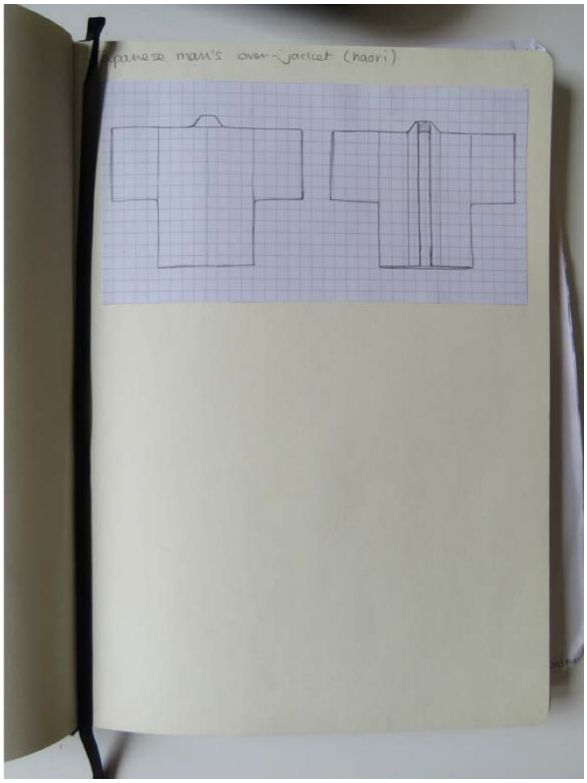

Hungarian cloak


Shirt Daghestan
gusset
Afghanistan - trousers
460cm wide!


Kurdish Winter Coat
Persian shirt


Punjab, Cashmere
tshoga - over garment
Punjab chublis shirt
gusset


Woman's
jacket
Burma
CB seam
Men's kimono
to be
worn
with
belt


Japanese man's over-jacket (haori)

Appendix 5 - Garments constructed with welded or bonded elements

Clockwise from top left: Ultrasonic welded Puma clever little bag , RF welded Muji Freecut mac, Bonded film and line bonding Nike pro turbospeed top, Line bonded tape Uniqlo briefs (Source: E.Etheridge, 2016)

Appendix 6 - Bonding and Welding Sample Sheets

Machine 1	
Model	Pfaff Seamsonic
Joining type	Welding
Heat Source	Ultrasonic
Additional info.	Works with most synthetic fibres, more than 70% content
Options	4 x anvils available for different seam designs
Notes. Various designs of anvils available from manufacturer	

Machine 2	
Model	Sew Systems AT800K Right Hand Knife Film Lay down
Joining type	Adhesive Bonding
Heat Source	Heat / optional hot air
Additional info.	6mm tape width
Options	Adjustable for tape widths up to 12mm
Notes. Uses tape feeder Bonds one side of double sided adhesive tape and cuts off excess fabric to right hand side.	

Machine 3	
Model	Sew Systems AT750FOA-CM Feed of the Arm Bonding machine
Joining type	Adhesive Bonding
Heat Source	Hot air / heated chute /heated belt

Additional info.	
Options	Plate can be altered
Notes. This machine has been altered with flat plate for bonding.	

Machine 4	
Model	Ardmel HSP-500 Pneumatic High Pressure Bonding Press
Joining type	Adhesive Bonding
Heat Source	Heat & pressure
Additional info.	
Options	
Notes. For use with bonding films Adjustable heat and timing Plates available for bonding zips etc.	

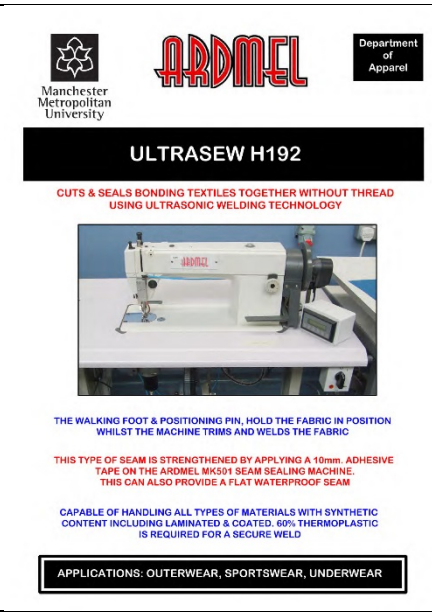
Machine 5	
Model	Ardmel MK-501 Seam Sealer
Joining type	Adhesive Bonding
Heat Source	Hot air
Additional info.	This model accommodates tape width of 10mm

Options	Suitable for tape widths up to 28mm
Notes. Tape feeder Roller Width 28mm Automatic scissor cut off function	

Machine 6	
Model	Sew Systems AT750VM Bonding Machine with binding foot
Joining type	Adhesive Bonding
Heat Source	Hot air top/bottom Heated foot & Platen
Additional info.	
Options	Can be used without binding foot for flatbed bonding only
Notes. Tape feeder and binding foot attachment	

Machine 7	
Model	Ardmel Utility Table
Joining type	Bonding
Heat Source	Heat & pressure
Additional info.	Used for pre-bonding tacking

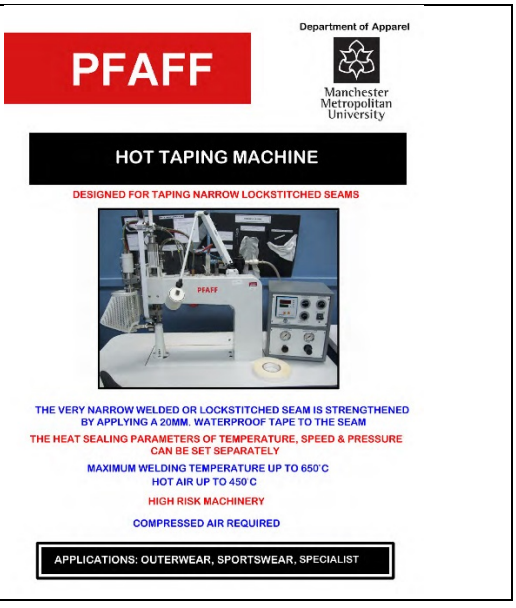
Options		
Notes. Can be used in conjunction with other bonding technologies to tack pieces into place prior to bonding		

Machine 8		
Model	Ardmel Ultrasew H192	
Joining type	Welding	
Heat Source	Ultrasonic	
Additional info.	Seals and cuts to right hand side	
Options		
Notes. Works with most synthetic fibres, more than 70% content		

Machine 9		
Model	Ardmel Ultrasonic welding / jig cutter	
Joining type	Welding	

Heat Source	Ultrasonic
Additional info.	
Options	According to templates
Notes. Use in conjunction with plastic templates for cutting out desired shape Cut & seals edges. Capable of handling all types of fabrics with synthetic content.	

Machine 10	
Model	Pfaff 8304 heat sealing machine
Joining type	Welding
Heat Source	Hot air & hot wedge
Additional info.	For use with tape widths up to 20mm
Options	
Notes. For use with thermoplastic heat sealing tapes for sealing stitched seams or applying decorative tapes.	

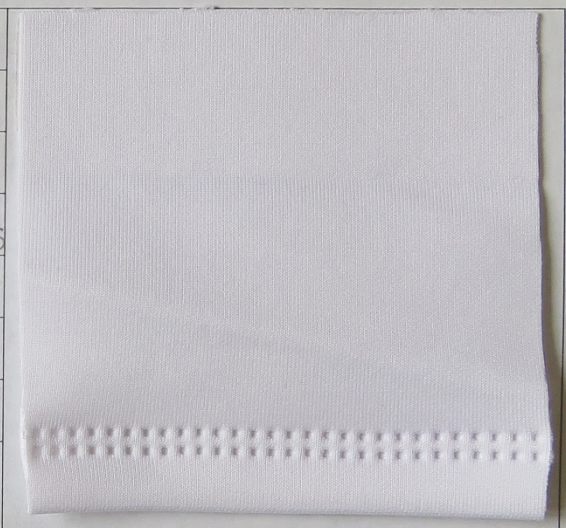


Machine	Operation
1	Single lap seam anvil 296-256384-S

Suitable for:
Seaming

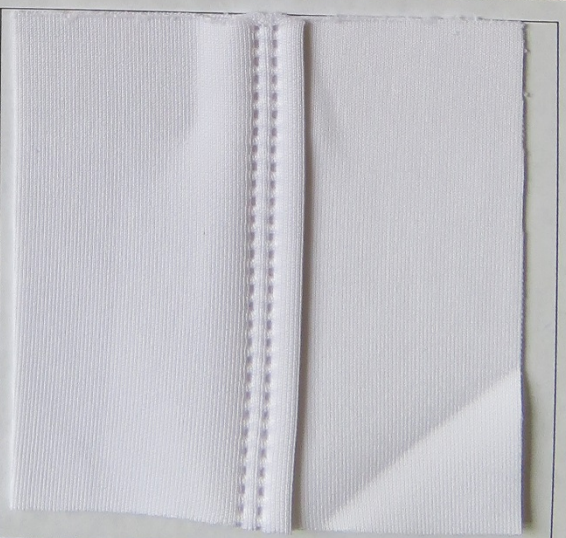
Machine	Operation
1	Hem edge single seam Anvil - 296-256384-S

Suitable for:
Hems and straight neck edges

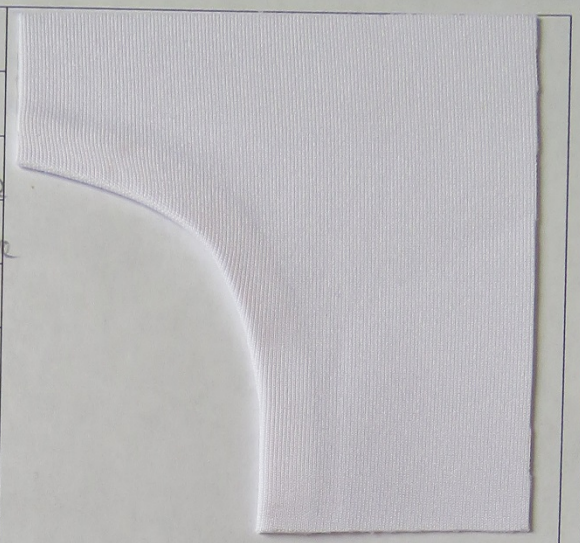


Machine	Operation
1	Semi fold lap seam with single seam Anvil-296-256384-S

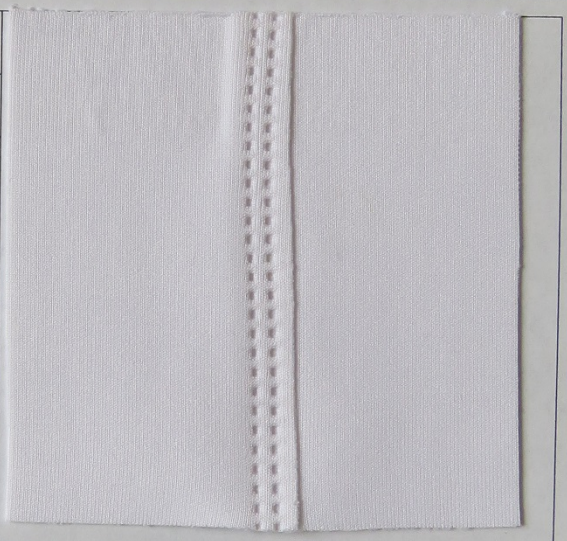
Suitable for:
Seaming



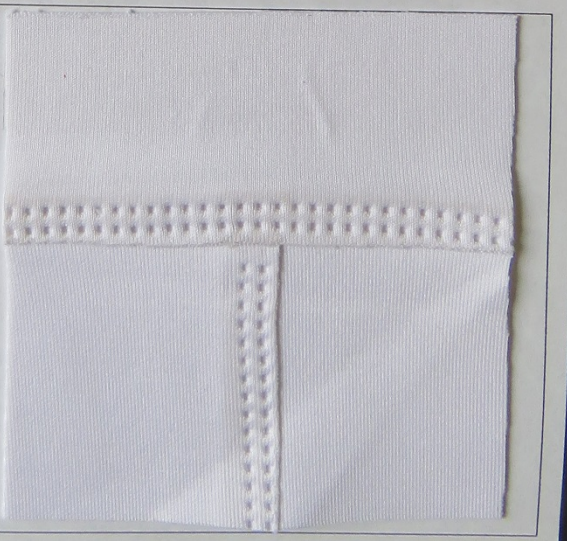
Machine	Operation
2	Lay down bonding machine with clear adhesive tape
3	Turn over edge to seal.
Suitable for: Neckline / armhole / curved hem	



Machine	Operation
1	Single lap ultrasonic seam with streten. anvil 296-256384x5
Suitable for: Seams that require slight streten.	

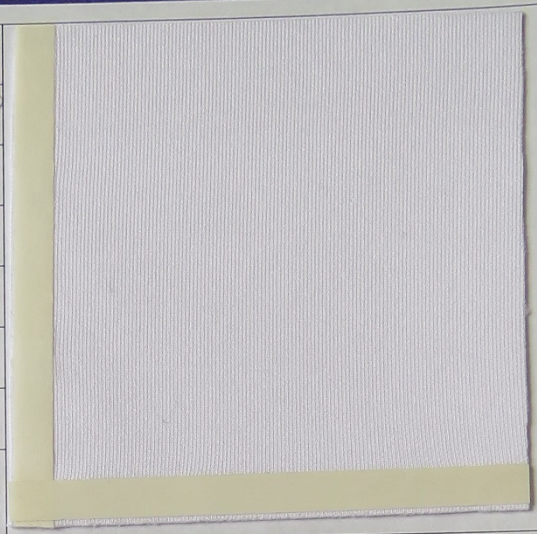


Machine	Operation
1	'T' shape lap seams ultrasonic anvil 296-256384x5
Suitable for: T shape seaming	



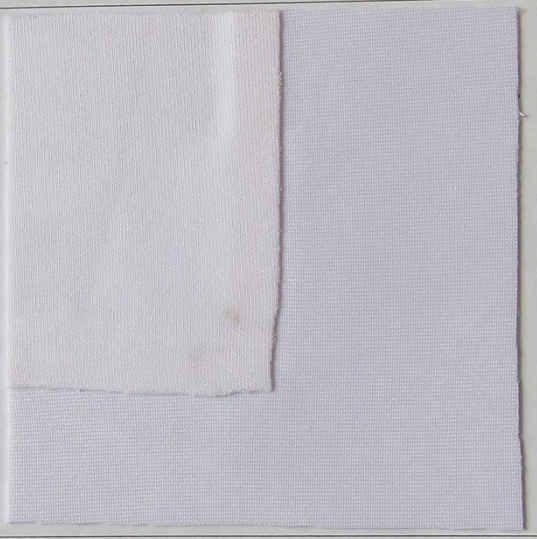
Machine	Operation
2	Lay down bonding tape (0·6mm) on edge of fabric Repeat to corner

Suitable for:
First stage of bonding



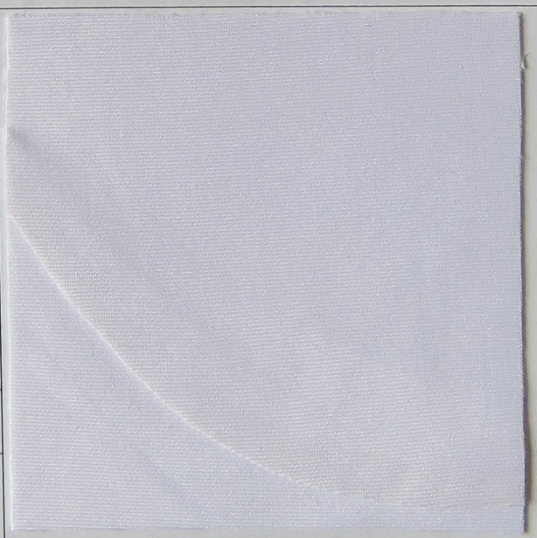
Machine	Operation
2	Lay down bonding tape (0·6mm) on edge of fabric Repeat to corner
7	Pre bond tack into outer piece
3	Heat bond over tape seam to finish

Suitable for:
Flat seams with corner



Machine	Operation
2	Lay down bonding tape (0·6mm) on curved outer edge of seam
7	Pre bond tack to outer piece
3	Flat bed heat bond to finish seam

Suitable for:
Flat seams with curve



Machine	Operation
6	Bind first
step 1	edge with
	15mm tape
step 2	Bind secand
	edge
	cut tape level to edge

Suitable for: 90° edges / hems

Machine	Operation
6	Bind first
step 1	edge with
	15mm tape
step 2	Bind secand
	edge and continue for
	strap

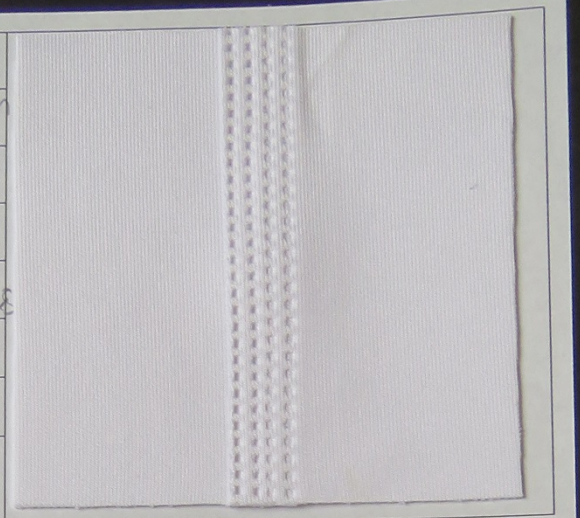
Suitable for: Applying straps / edges

Machine	Operation
7	Pre-tack
	deep hem with tape
3	Bond tape in
	place on
	external
	side

Suitable for: Hem one side is invisible reverse is decorative hem

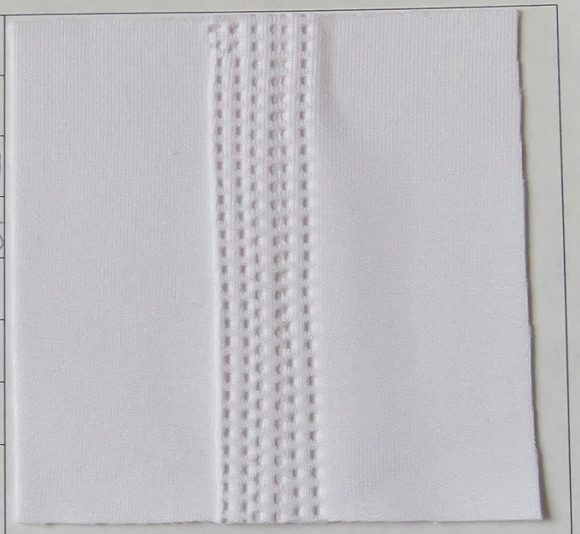
Machine	Operation
1	Single lap seam
	Two lines of stitching parallel
	Anvil-296-256384-x5

Suitable for:
Seaming



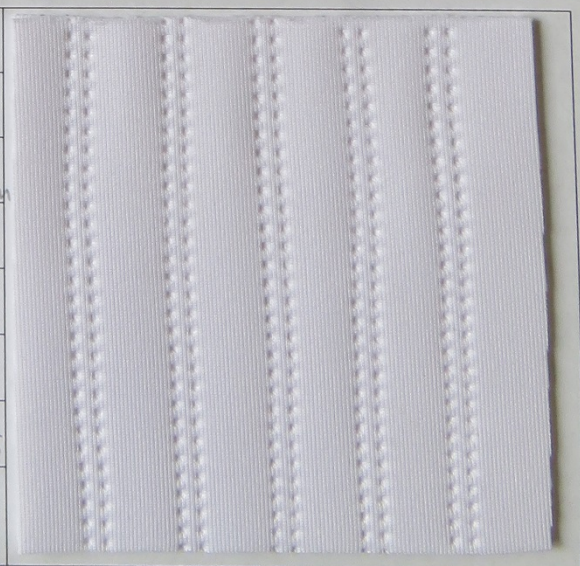
Machine	Operation
1	Single lap seam Three parallel
	lines of stitching
	Anvil-296-256384-x5

Suitable for:
Seaming



Machine	Operation
1	Single parallel
	stitch lines 1.5cm
	apart on double
	thickness of
	fabric
	Anvil 296-256384-x5

Suitable for:
Decorative / quilting / joining two different fabrics

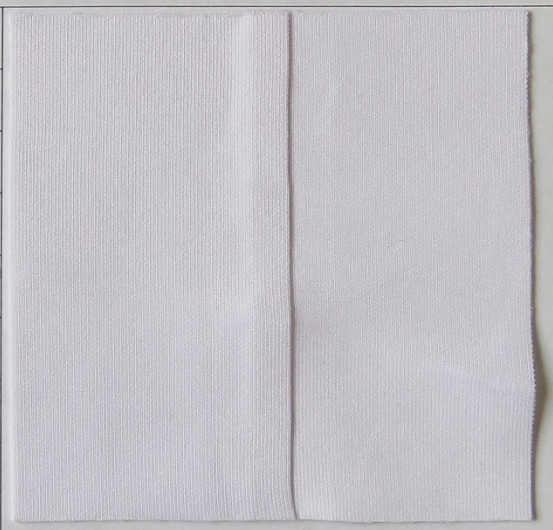


Machine	Operation
2	Lay down bonding tape on edge of fabric 0·6mm adhesive tape

Suitable for:
First stage of edge bonding

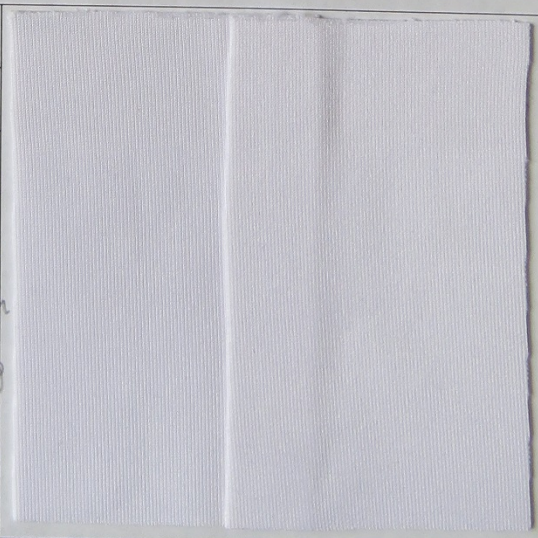
Machine	Operation
2	Lay down bonding tape (0·6mm) on fabric edge
7	Remove paper backing pre-bond tack
3	lapped seam Flat bed bond to secure

Suitable for:
Seaming



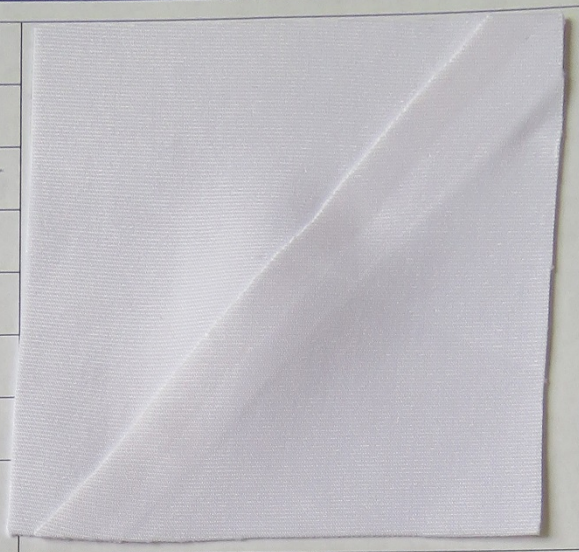
Machine	Operation
2	Lay down bonding tape on edge of fabric (0·6mm) Repeat on second fabric
7	Remove paper on both edges and tack lapped seam
3	Flat bed bonding to secure

Suitable for:
Seaming



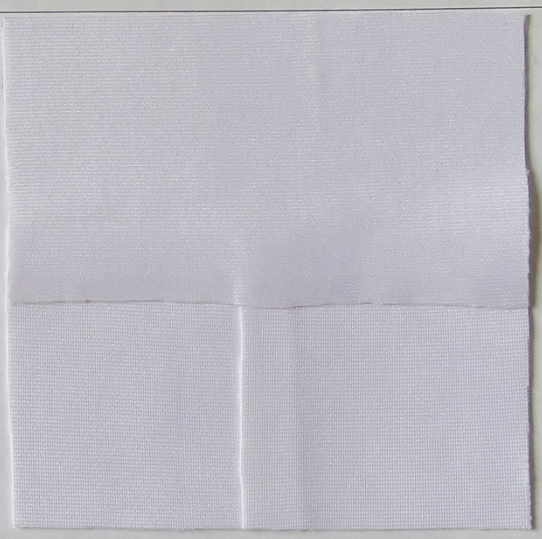
Machine	Operation
2	Diagonal adhesive
	bonded seam tap
step 1	lay down
step 2	adhesive
3	seam

Suitable for:
Diagonal seam where sheten is required



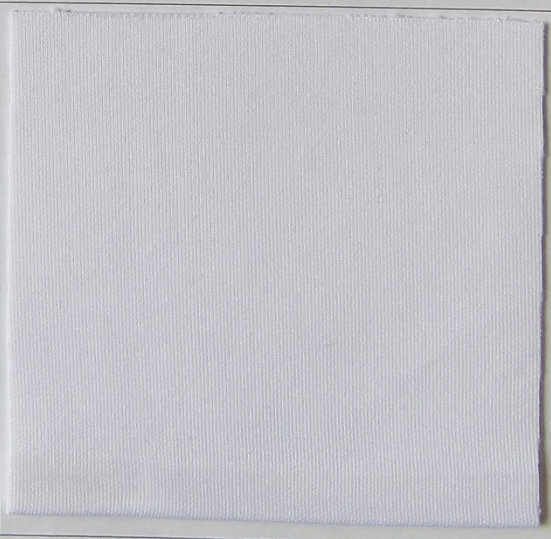
Machine	Operation
2	Lay down clear adhesive tape
4	seam edge
	Repeat

Suitable for:
T shape seaming



Machine	Operation
	Narrow
	adhesive tape hem
2	Lay down tape
4	Turn hem

Suitable for:
Narrow hem edge

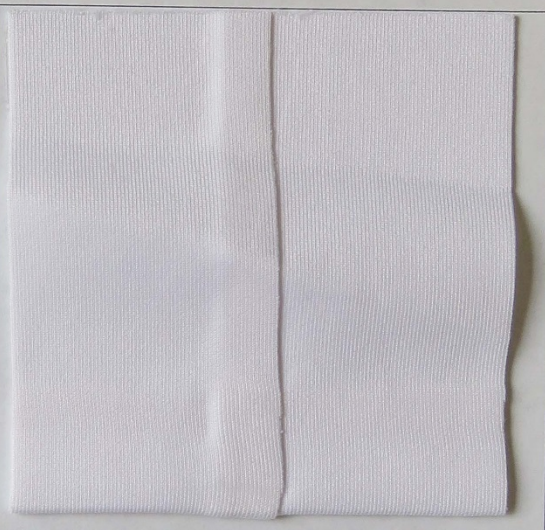


Machine	Operation
2/3	Continuous laydown bonding
or	
4	Heat press for short seams

Suitable for:
Invisible' hem-deep with clear adhesive tape

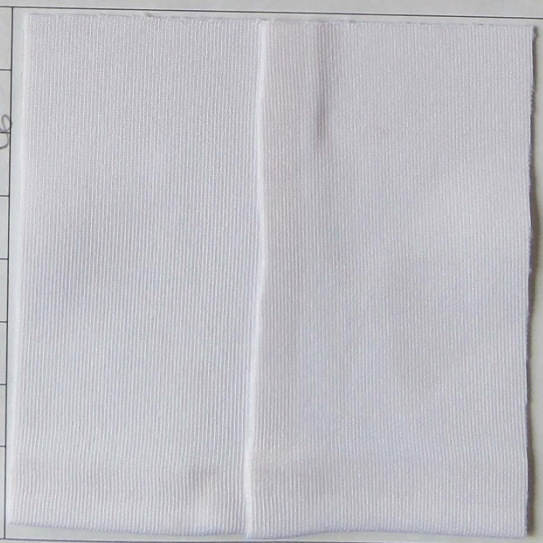
Machine	Operation
2/3	Continuous laydown bonding
	seam + hem w clear adhesive tape
step 1	seam
step 2	turn up hem

Suitable for:
Seam/hem combination



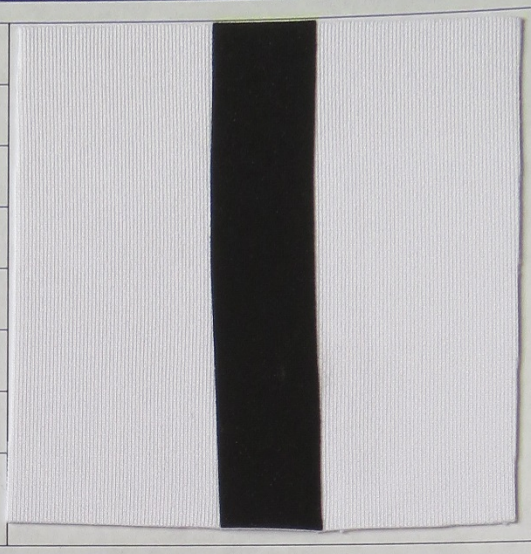
Machine	Operation
2/3	Continuous lay down bonding w. adhesive tape
step 1	turn up hem
step 2	Seam

Suitable for:
Seam/hem alternative combination



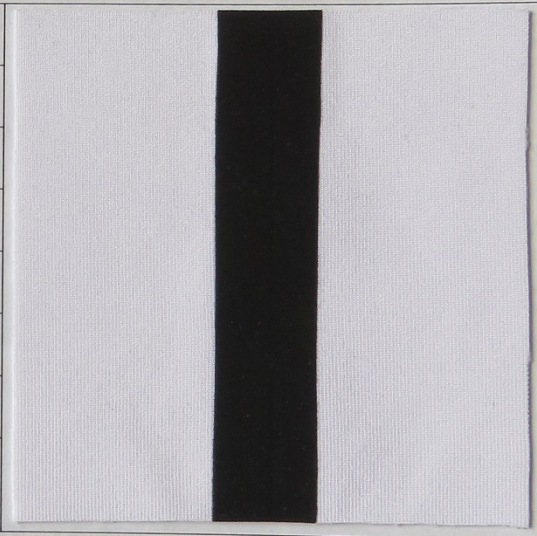
Machine	Operation
3	Lay down continuous
or 4	Bonding press for short seams

Suitable for: Seaming and decorative



Machine	Operation
3	Lay down continuous bonding with tape
step2	Apply tape to reverse side

Suitable for: Seaming reversible garments / extra strength

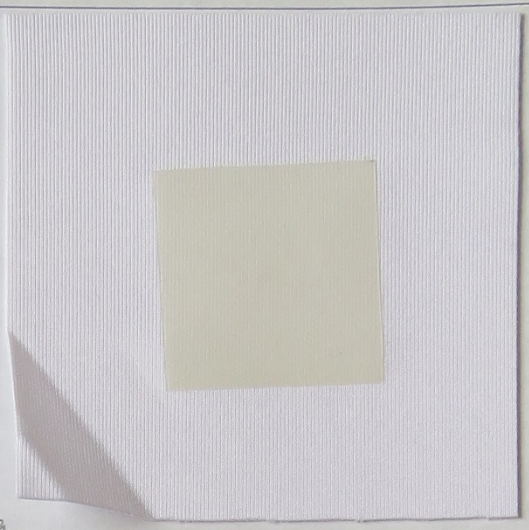


Machine	Operation
3	Lay down continuous bonding machine
	Topshitched'
1	with ultrasonic
	welder

Suitable for: Decorative seam / hem finish

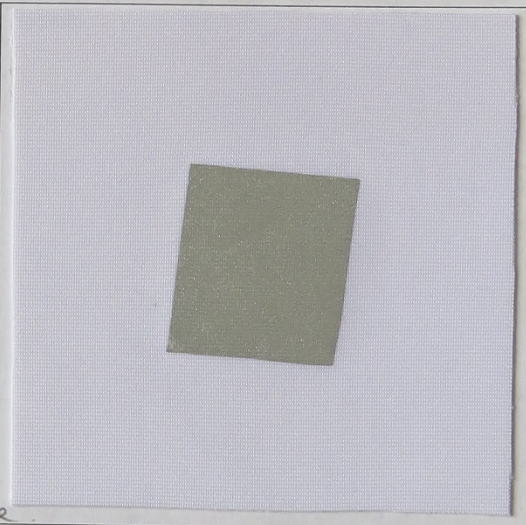
Machine	Operation
4	Heat pressed
	clear
	bonding film

Suitable for: Film can be cut to any shape for decorative / shape retaining



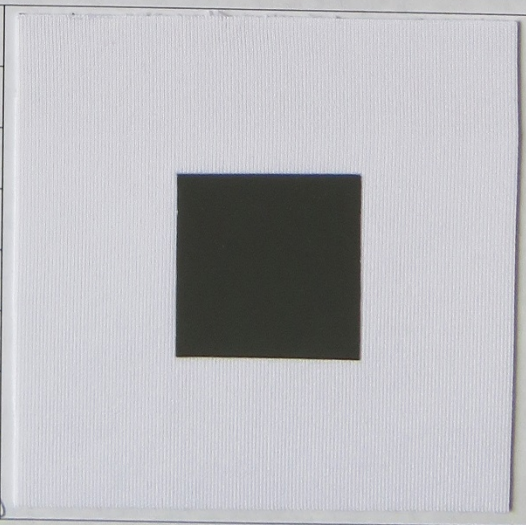
Machine	Operation
4	Heat pressed
	Reflective
	bonding film

Suitable for: Film can be cut to any shape for decorative / retain fabric shape



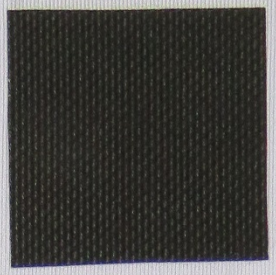
Machine	Operation
4	Heat pressed
	matte black
	bonding film

Suitable for: Can be cut to any shape for decorative / shape retaining



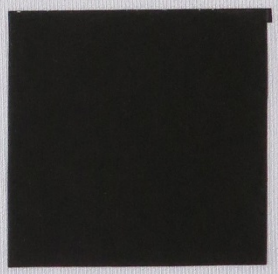
Machine	Operation
4	Heat press textured bonding film

Suitable for: Film can be cut to any shape for decoration or to strengthen / retain shape



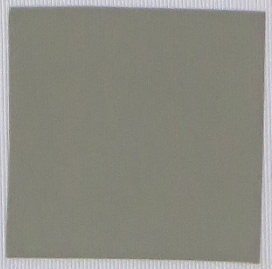
Machine	Operation
4	Heat press matte black bonding film

Suitable for: Cut to shape for decoration / to strengthen retain shape of fabric



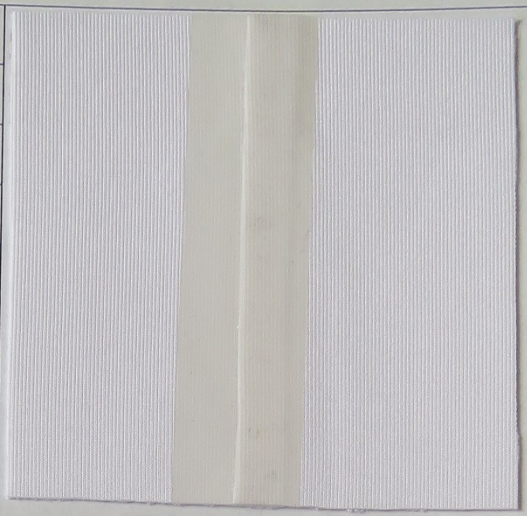
Machine	Operation
4	Heat press matte grey bonding film

Suitable for: Cut to shape for decoration / to strengthen retain shape of fabric.



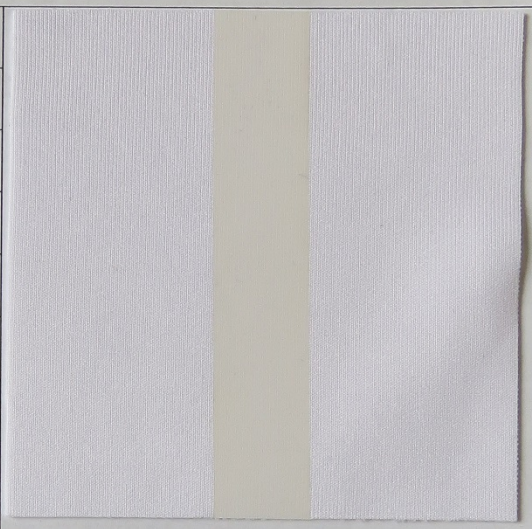
Machine	Operation
2	lay down adhesive tape
3	seam
4	Heat press clear bonding film

Suitable for: Strengthened decorative seam



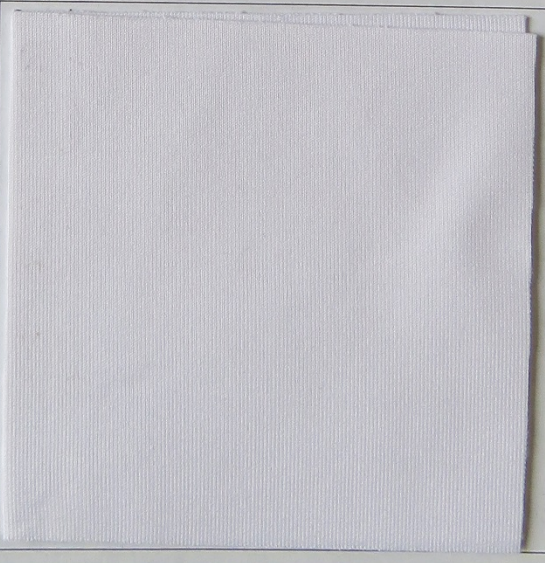
Machine	Operation
4	Heat pressed.
	clear bonding
	film

Suitable for: Decorative applique.



Machine	Operation
2	lay down
	adhesive tape
3	seam

Suitable for: External invisible seam

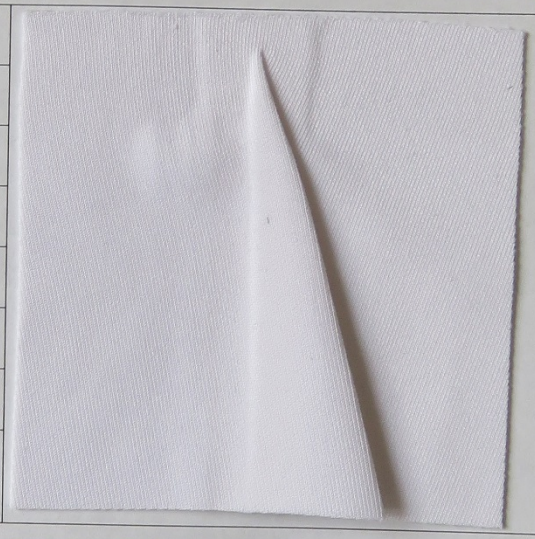


Machine	Operation
8	Narrow weld

Suitable for: seaming
* right side of seam leaves hardened edge

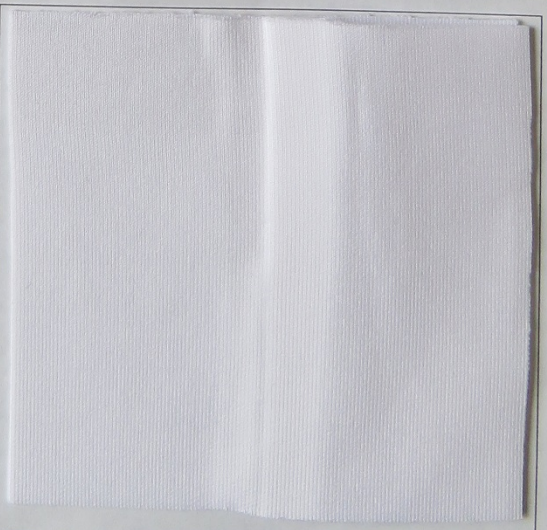
Machine	Operation
4	Heat pressed dart - invisible reverse side used bonding tape

Suitable for:
Darting to shape garments



Machine	Operation
4	Two sided tape seam allows a 90° 'seam'

Suitable for:
Produces a standing seam

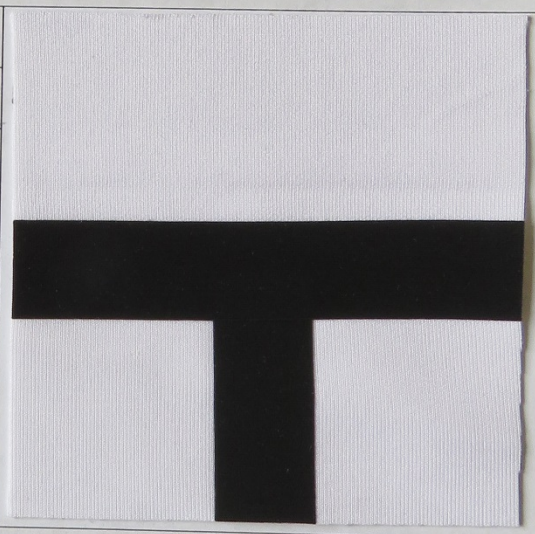


Machine	Operation
1	Continuous x2
	ultrasonic seam
	ami 296·256·384*S
4	Heat press
	tape to
	strengthen
	Bemis film

Suitable for: strengthening seam / Decorative tape finish

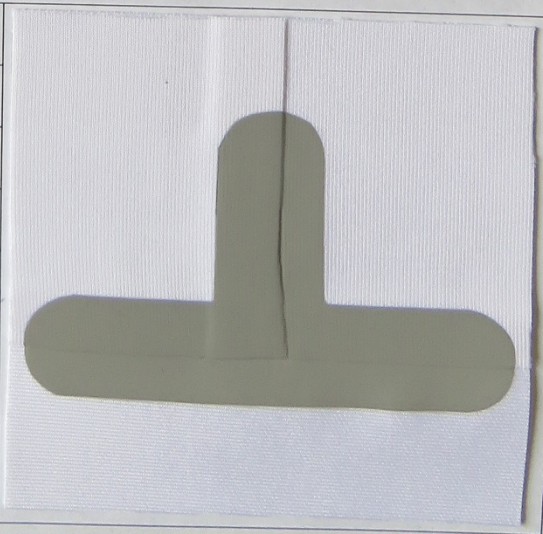
Machine	Operation
7	Pre-tack tape
4	Heat press to
	join

Suitable for: seaming shapes with no seam allowance



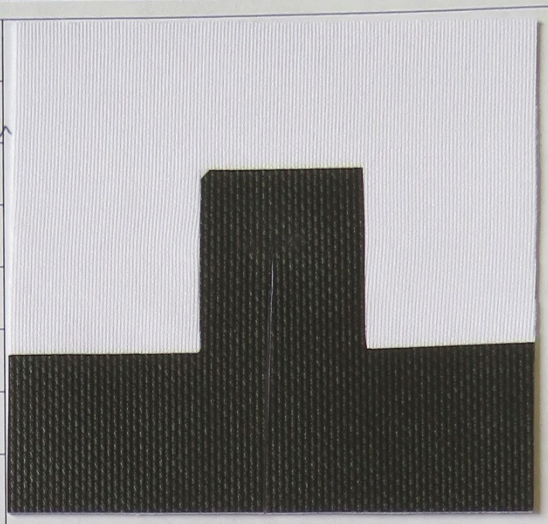
Machine	Operation
Step 1	As adhesive T seam
4	Shaped bonding
	film to decorate
	strengthen
	Bemis film

Suitable for: strengthening T joins and decorative applique



Machine	Operation
Sewing machine	Bartack opening - strength
4	Heat press Bonding film
	on both sides

Suitable for:
Sealing edges / hems decorative.



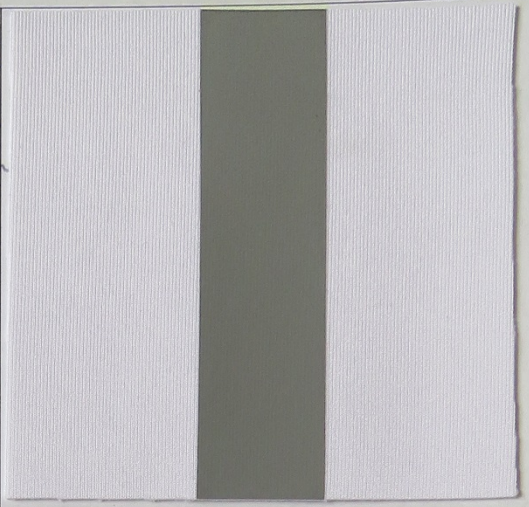
Machine	Operation
Sewing machine	Bartack opening to strengthe opening.
4	Heat press bonding film
	on both side

Suitable for:
Hem side openings eg dresses / tops etc

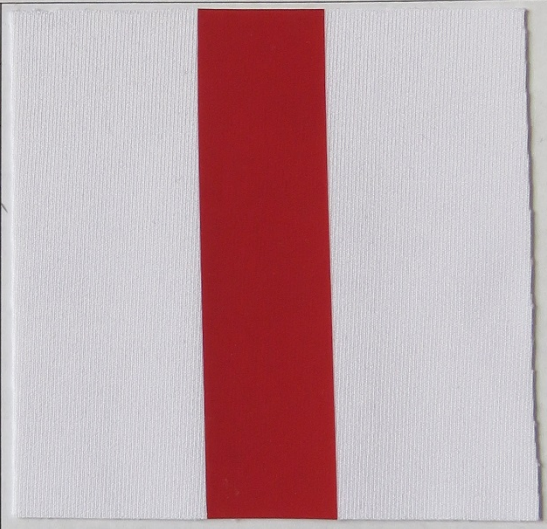
Machine	Operation
Sewing machine	Bar tack inner V
4	Heat press
	bonding film
	on one edge

Suitable for:
neck openings.

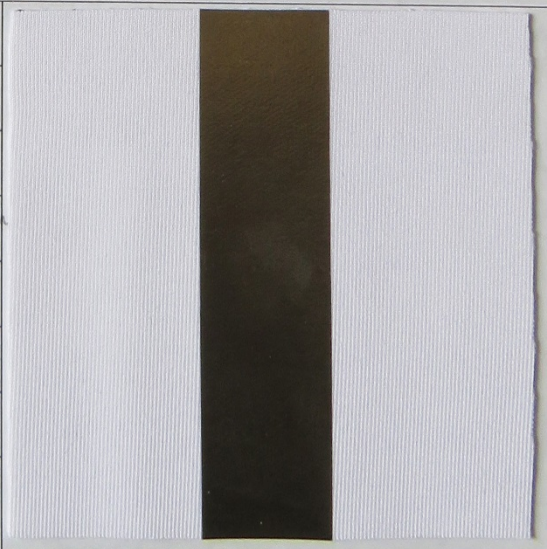
Machine	Operation
4 OR 5	For short tape appliqué For longer tape application with feed
	Framis tape
Suitable for: Applying tape for applique / decorative	



Machine	Operation
4 OR 5	Short tape application For longer tape application with feed
	Framis tape
Suitable for: Applying tape for applique / decorative	



Machine	Operation
4 or 5	For short tape application For longer tape application with feed
	Framis
Suitable for: Applying tape for appliqué / decorative	

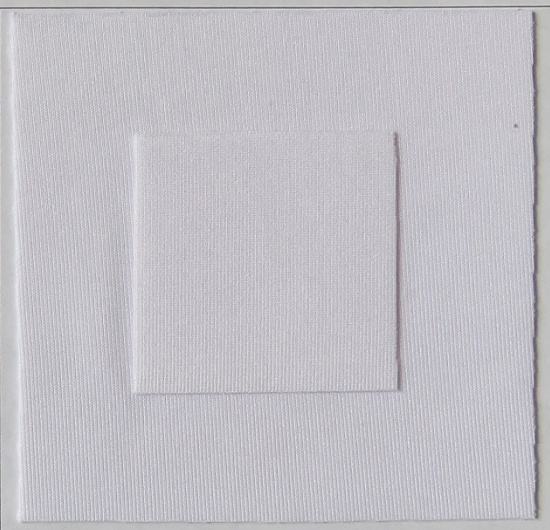


Machine	Operation
4	Heat press bonding adhesive.

Suitable for: Sheet adhesive can be cut to shape and allow fabric to be heat pressed to attach.

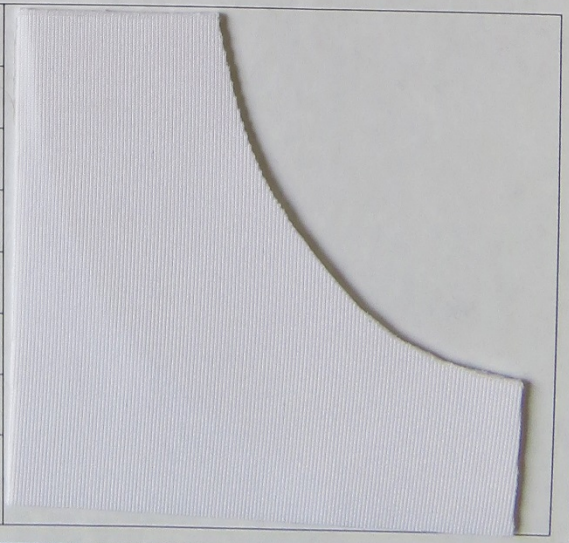
Machine	Operation
4	Heat pressed adhesive applied to
step 1	
	Square
step 2	Heat pressed onto fabric

Suitable for: Applying and sealing fabric edge to create applique



Machine	Operation
4	Heat pressed adhesive
step 1	applied to curved facing piece
step 2	Facing piece heat pressed in place

Suitable for: curved flat edges / neck/arm hem

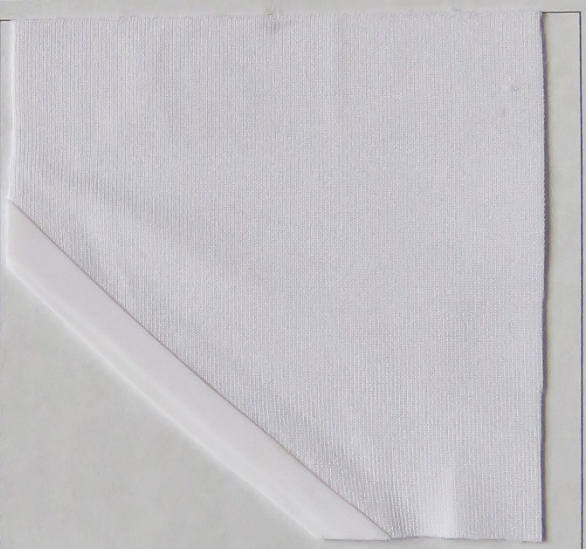


Machine	Operation
6	Bound edge with 15mm tape

Suitable for: Hems / edges / straight openings.

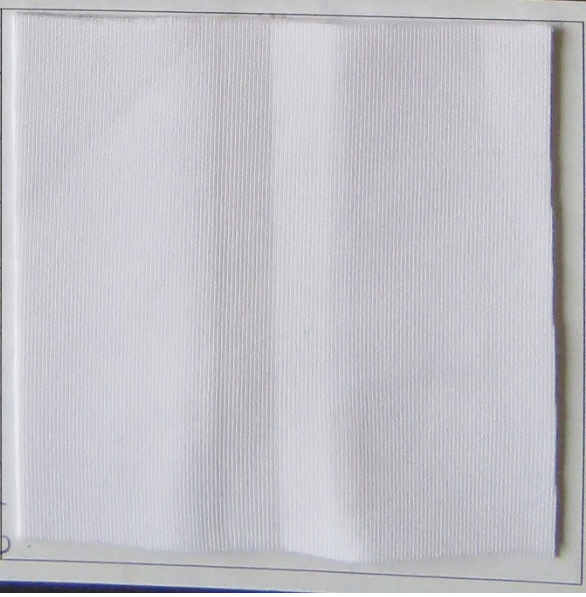
Machine	Operation
6	Bound edge with 15mm tape

Suitable for: Binding stretch fabric at 45° will not go stretch fabric.



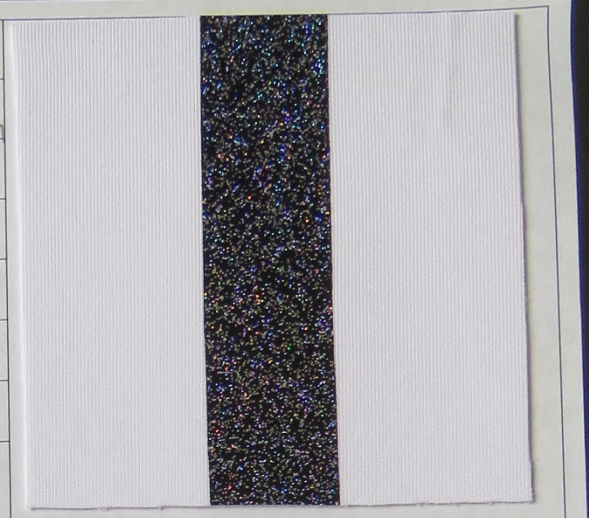
Machine	Operation
3	Cross shaped seam

Suitable for: Allows for intersected seam Double layer seams.



Machine	Operation
10	Hot wedge tape application
	Framis tape

Suitable for:
Decorative feature.

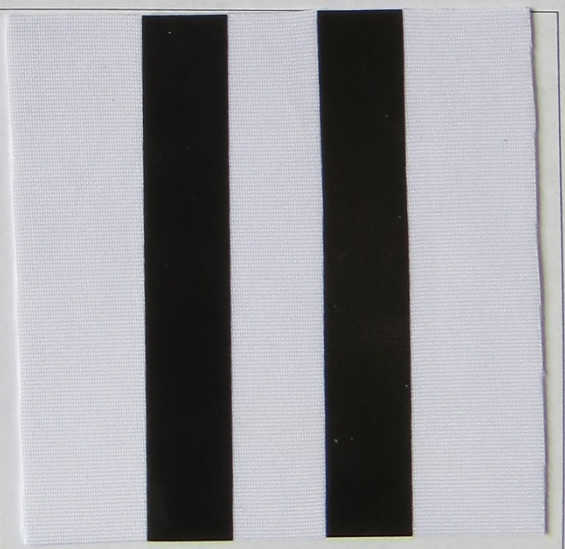


Machine	Operation
10	Hot wedge tape application
	Framistape

Suitable for:
Decorative feature

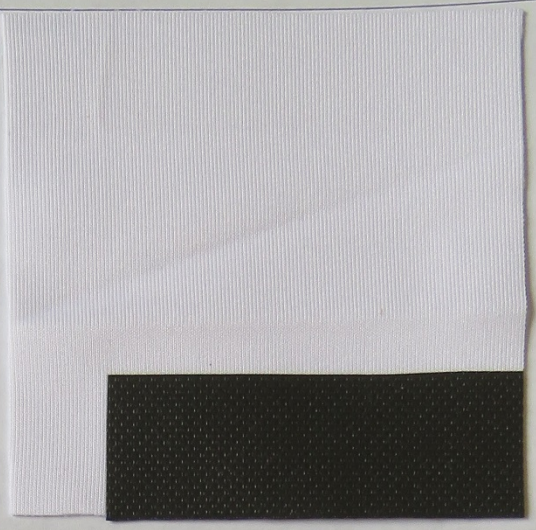
Machine	Operation
10	Hot wedge tape application
	Framistape

Suitable for:
Decorative feature.



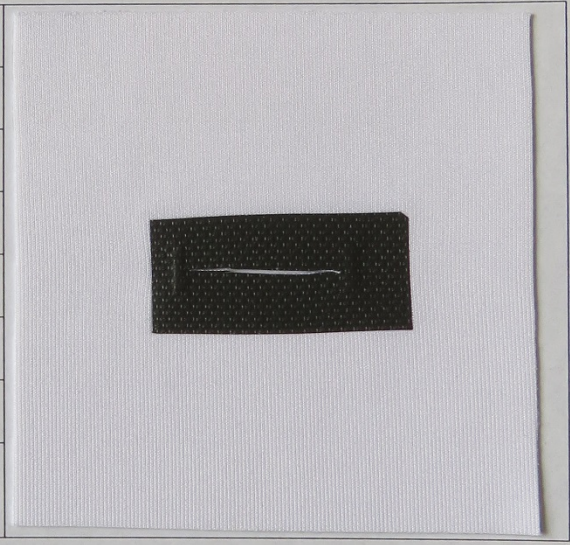
Machine	Operation
4	Fold bonding film over edge and heat press into place

Suitable for: Sealing hem edges.



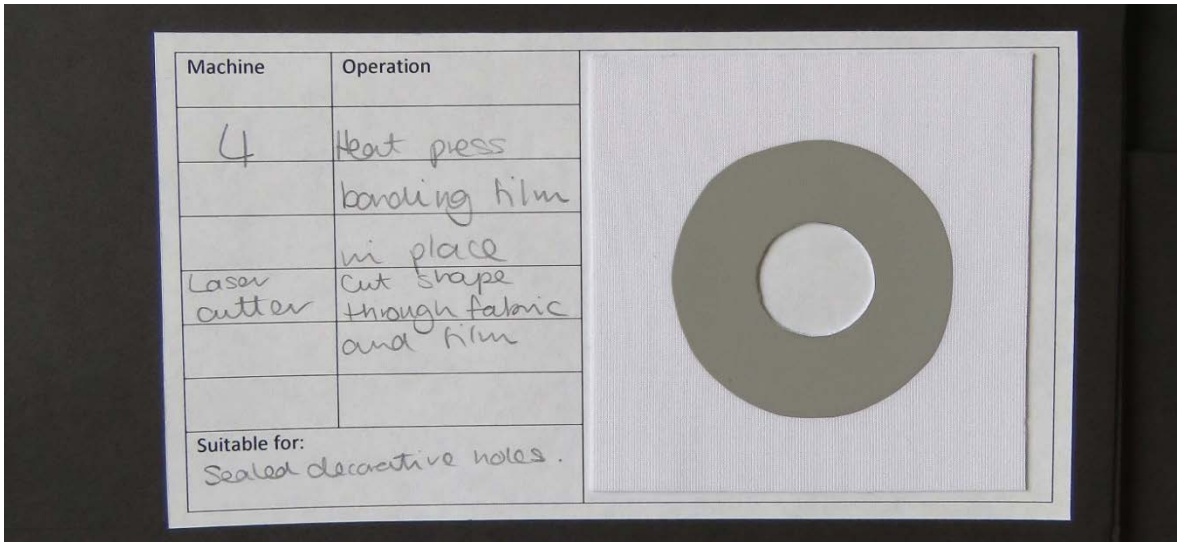
Machine	Operation
Sewing machine	Bar tack x 2 button hole opening.
4	Heat press bonding film on both sides of fabric

Suitable for: Button holes/openings



Machine	Operation
Sewing machine	Bar tack x 2 button hole openings
4	Heat press bonding film to both sides of fabric.

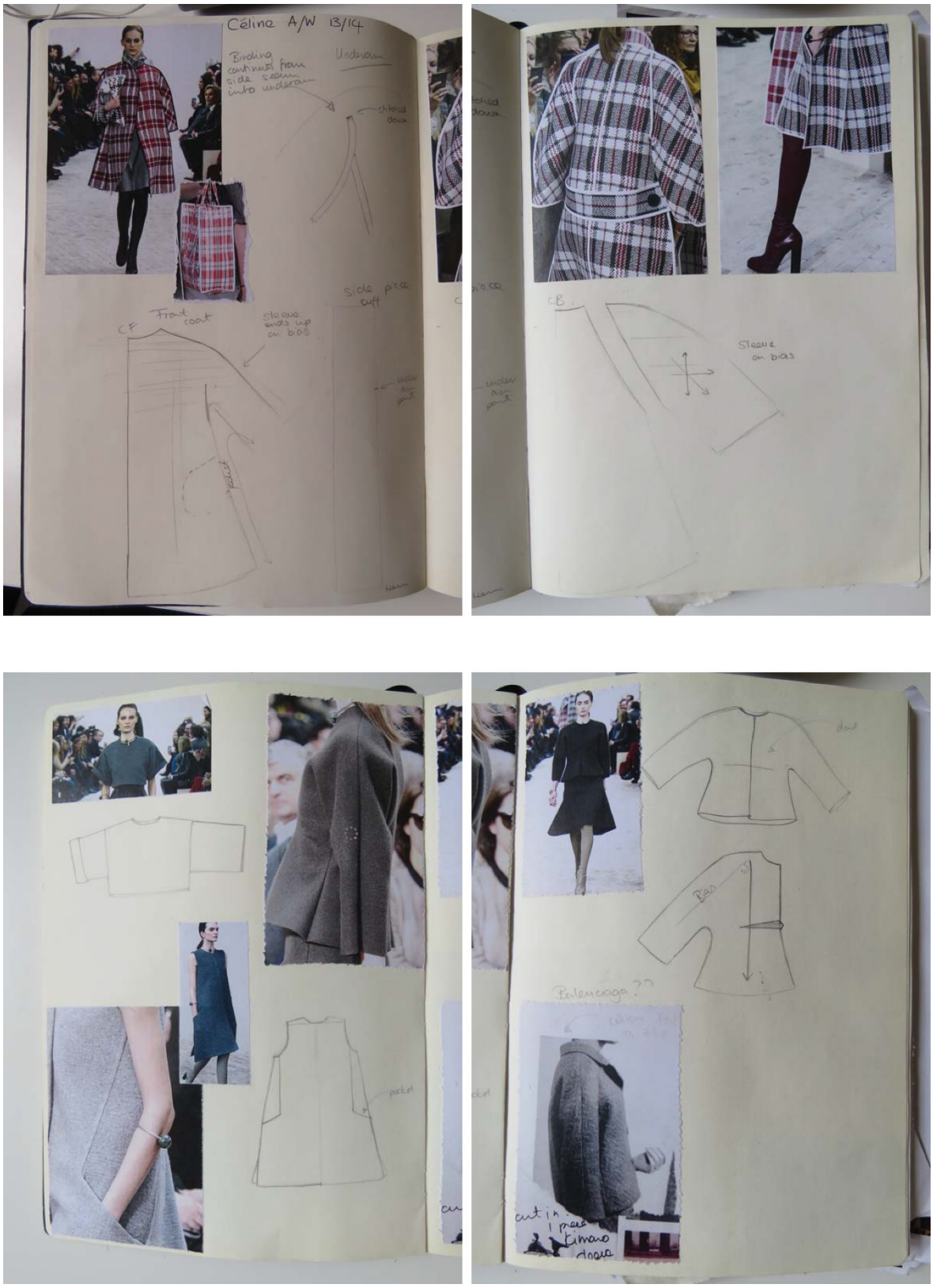
Suitable for: Buttonholes/openings

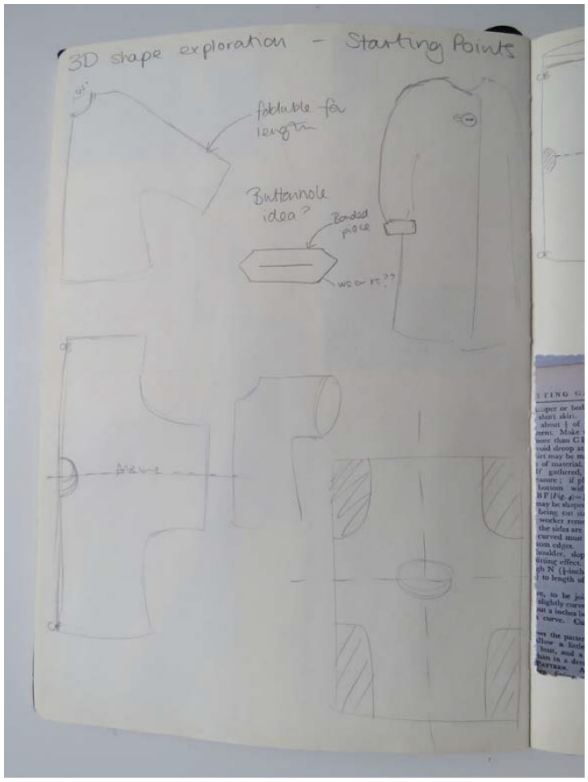


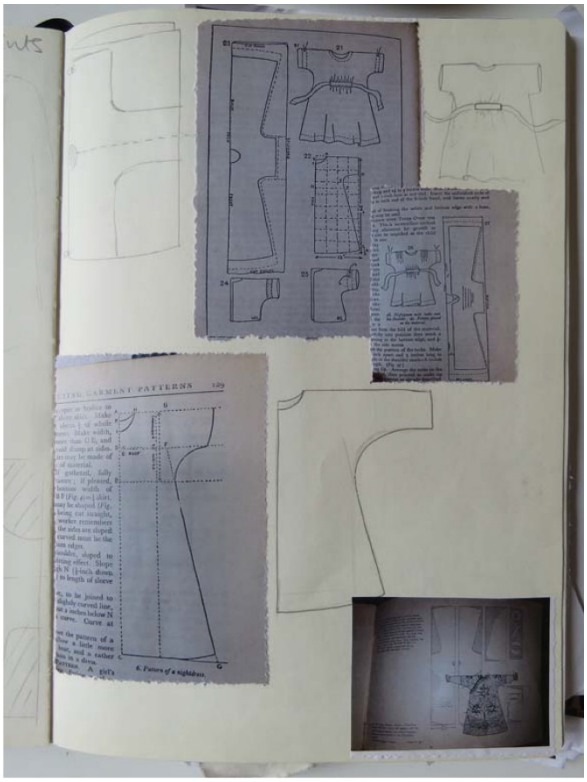
Machine	Operation
4	Heat press bonding film in place
Laser cutter	Cut shape through fabric and film

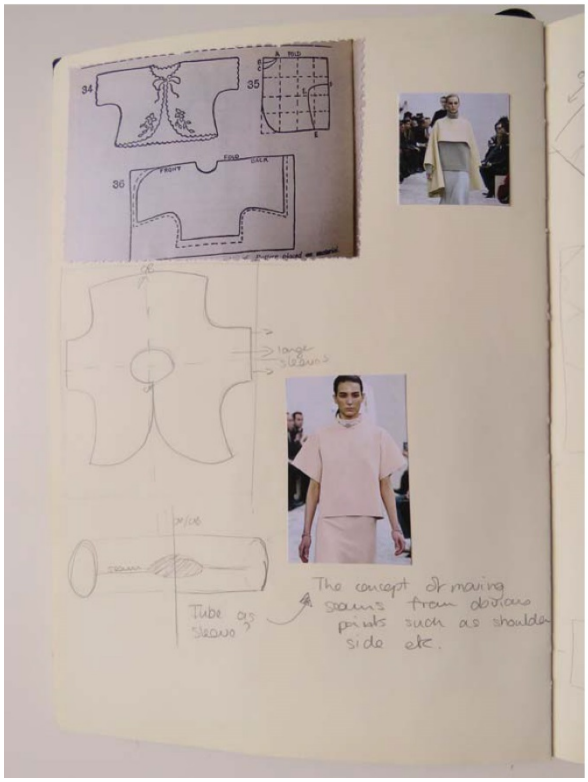
Suitable for:
Sealed decorative holes.

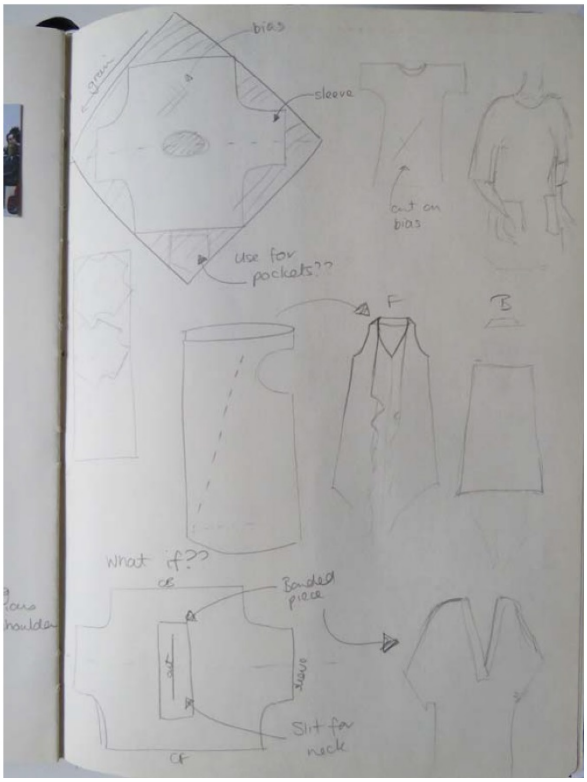
Appendix 7 - Development of pattern ideas in sketchbooks

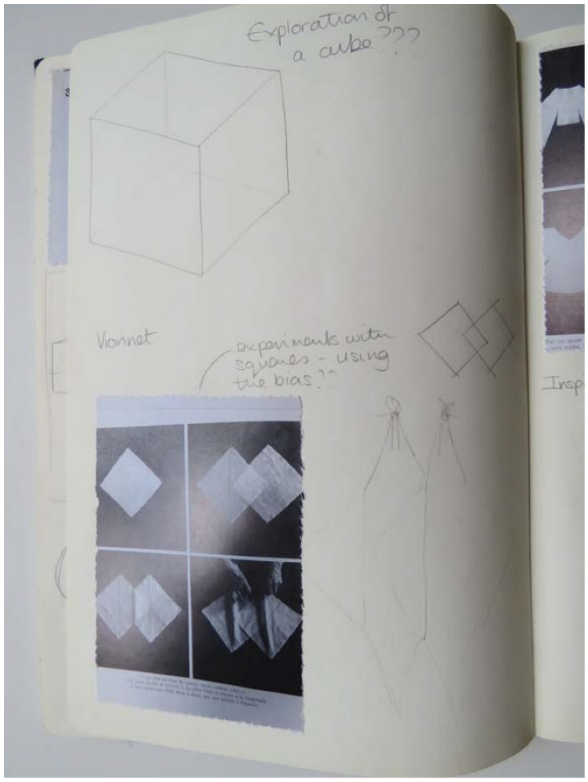


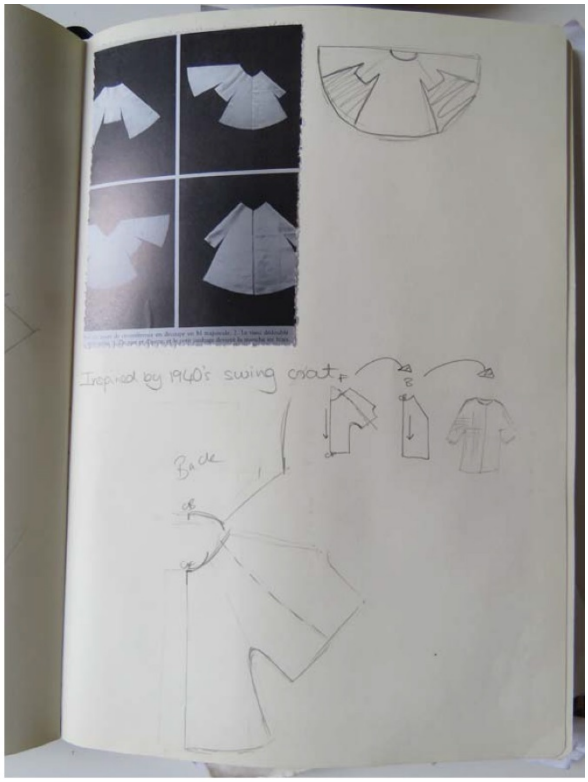

3D shape exploration - Starting Points
foldable for length
Buttonhole idea?
Banded piece
sleeve


GARMENT PATTERNS

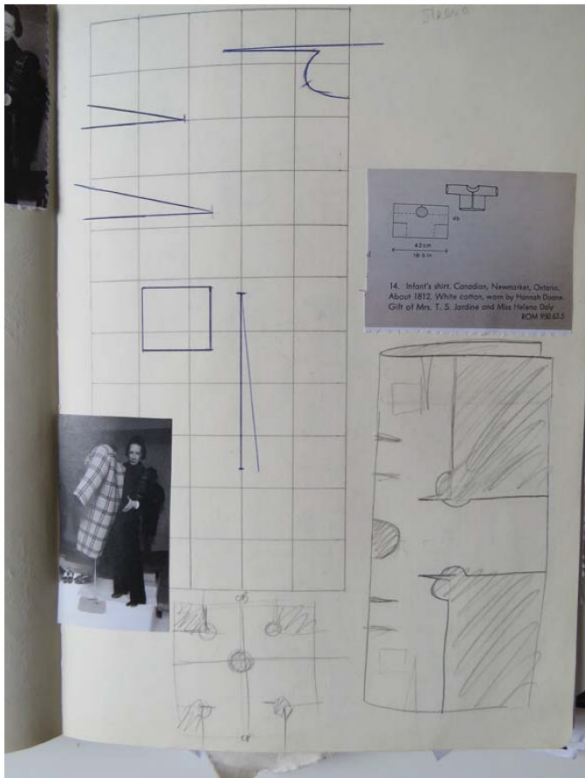

34
35
36
FRONT
BACK
longer sleeves
Tube as sleeve?
The concept of making seams from obvious points such as shoulder side etc.

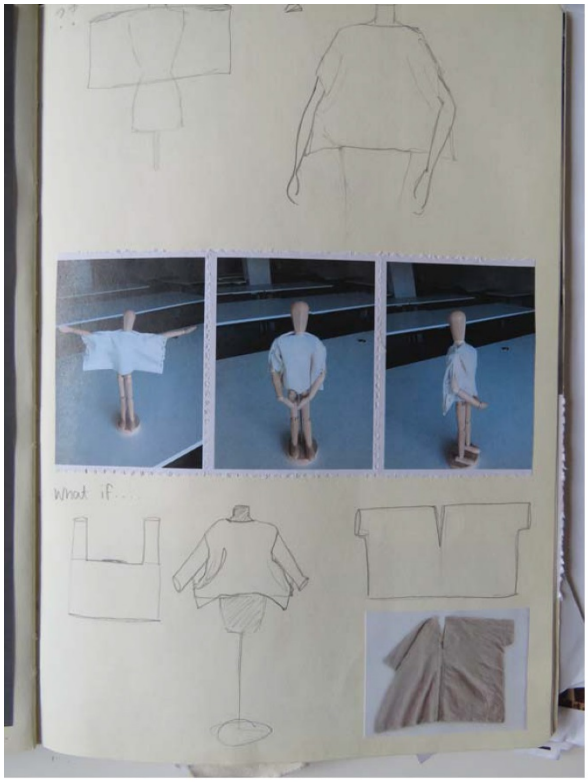

bias
sleeve
cut on bias
Use for pockets??
F
B
What if??
Banded piece
Slit for neck

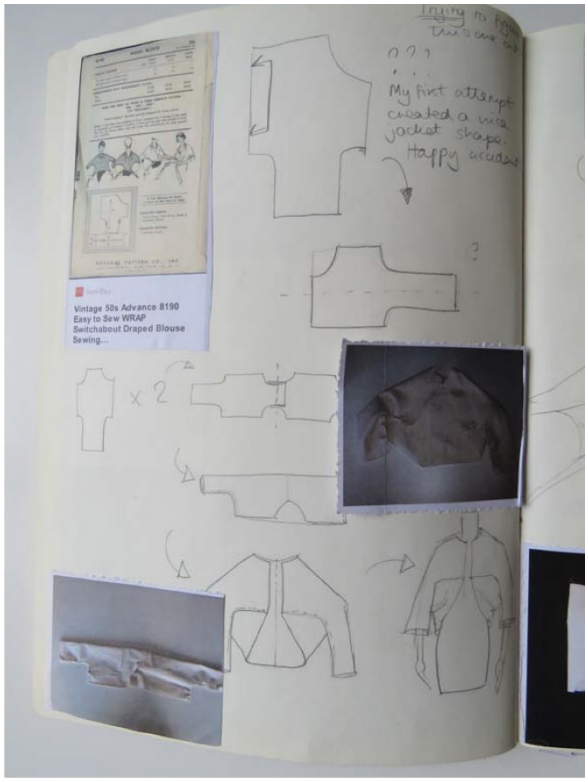

Exploration of a cube???
Vionnet
experiments with squares - using the bias?

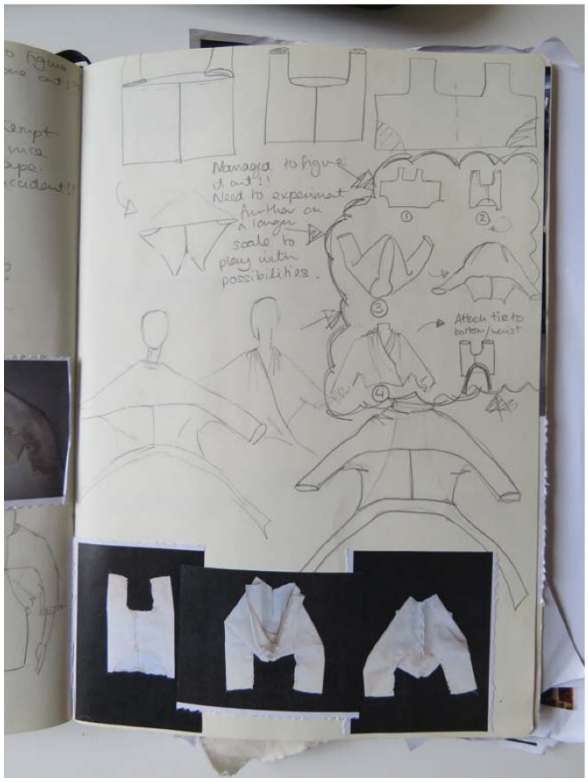

Inspired by 1940's swing coat
Back


Balenciaga one seam coat


14. Infant's shirt. Canadian, Newmarket, Ontario. About 1812. White cotton, worn by Hannah Doane. Gift of Mrs. T. S. Jardine and Miss Helena Daly. ROM 930.63.5


What if...


My first attempt created a nice jacket shape. Happy accident
Vintage 50s Advance 8190 Easy to Sew WRAP Switchabout Draped Blouse Sewing...
x 2

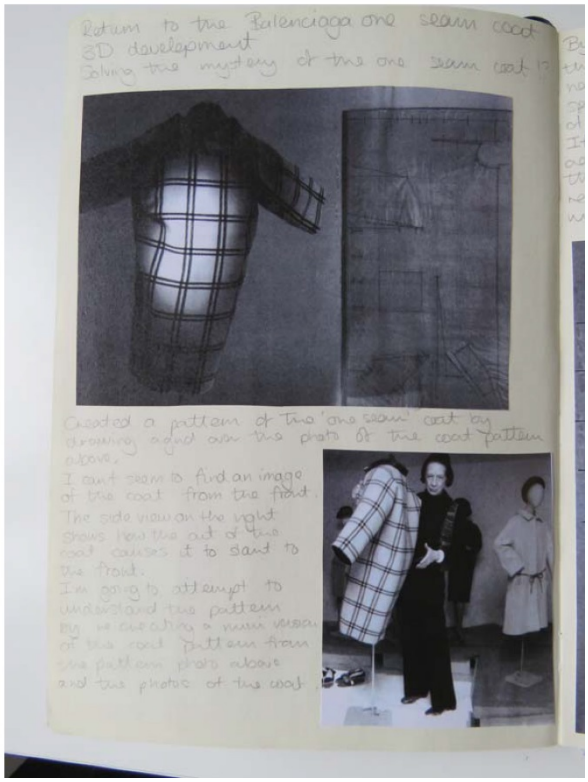

Managed to figure it out?! Need to experiment further on a longer scale to play with possibilities.
Attach tie to bottom/waist

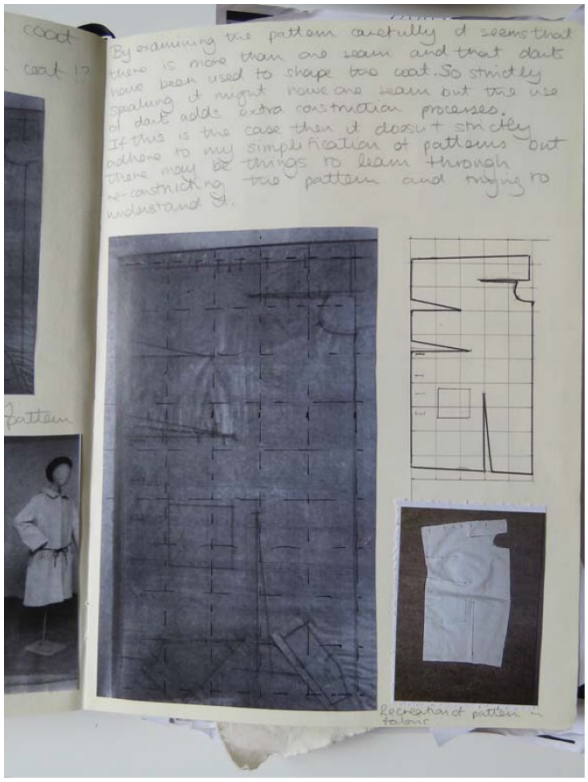

Ideas
Foldline
Cut on Bias
VS

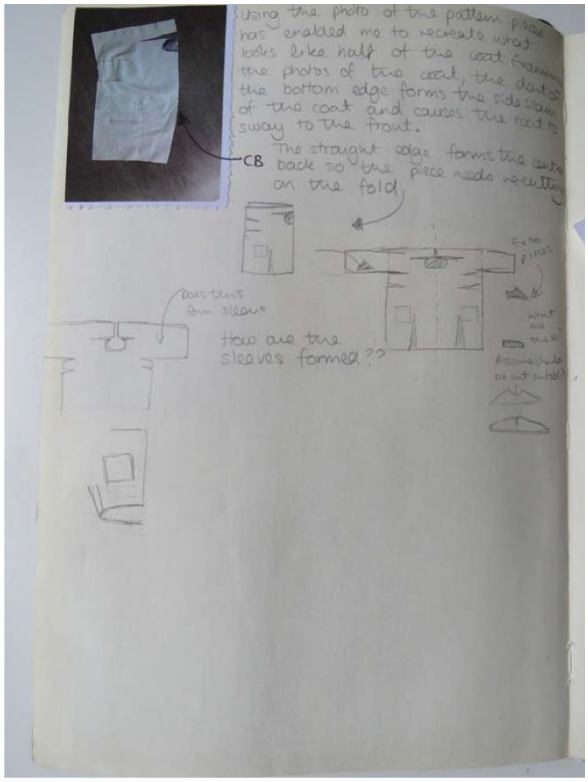

Straight of grain
Bias
kimono pattern


Straight of grain
Bias
Tie to front
Shortened version
Tie to back

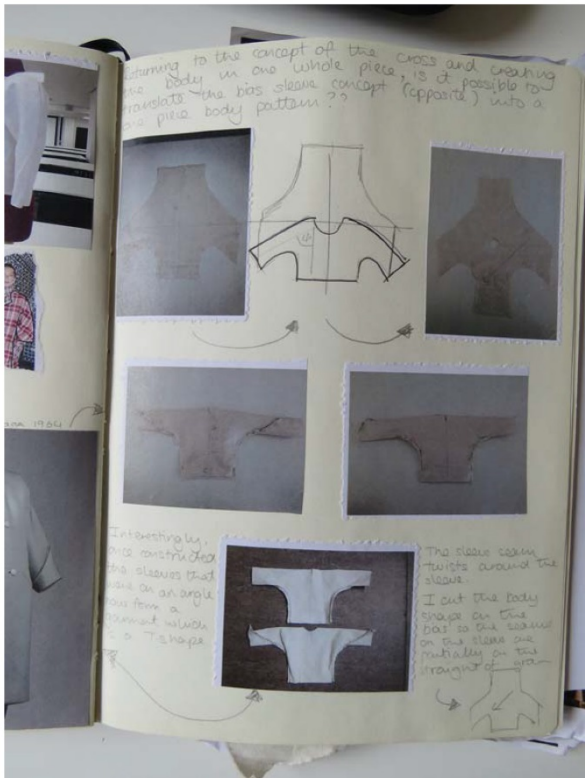

Straight knit version
Bias version

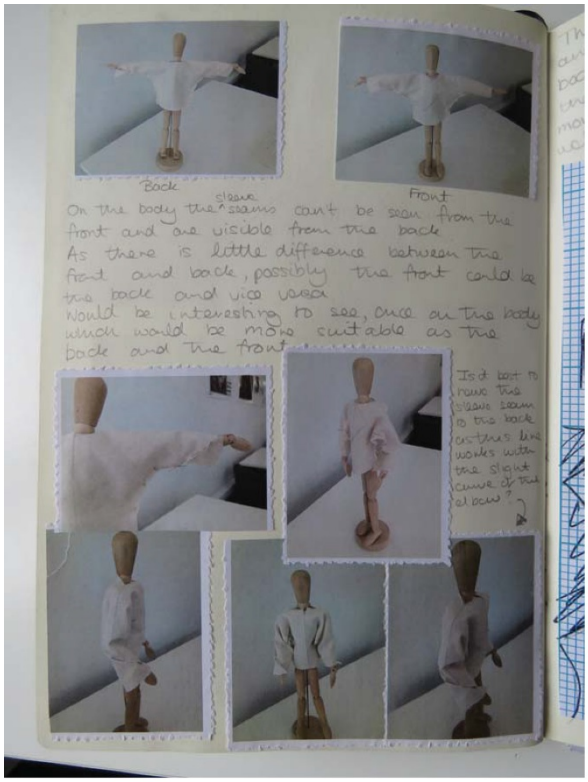

Return to the Balenciaga one seam coat
3D development
Solving the mystery of the one seam coat
Created a pattern of the 'one seam' coat by drawing around the photo of the coat pattern above.
I cut seam to find an image of the coat from the front
The side view on the right shows how the cut of the coat causes it to sand to the front.
I'm going to attempt to understand the pattern by re-creating a mini version of the coat pattern from the pattern photo above and the photo of the coat

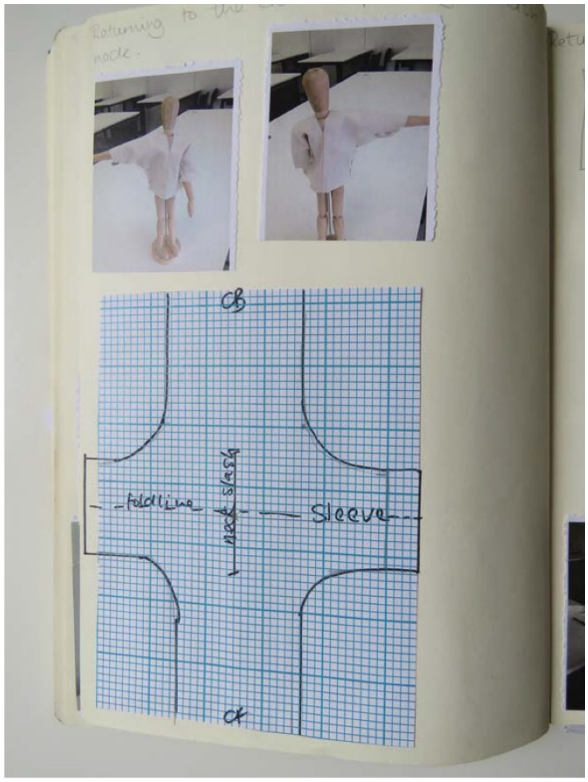

coat
coat 17
By examining the pattern carefully it seems that there is more than one seam and that darts have been used to shape the coat. So strictly speaking it might have one seam but the use of darts adds extra construction processes.
If this is the case then it doesn't strictly adhere to my simplification of patterns but there may be things to learn through re-constructing the pattern and trying to understand it.
pattern
Recreation of pattern in fabric


Using the photo of the pattern piece has enabled me to recreate what looks like half of the coat. Examining the photo of the coat, the dart at the bottom edge forms the side seam of the coat and causes the coat to sway to the front.
The straight edge forms the centre back so the piece needs recutting on the fold.
CB
How are the sleeves formed??

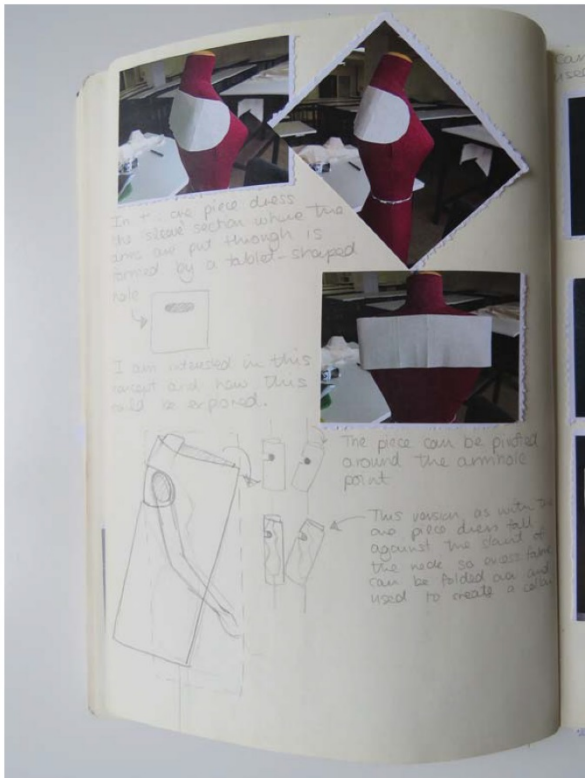

NE
Sleeve
Paleviana 1964
Twisted sleeve seam

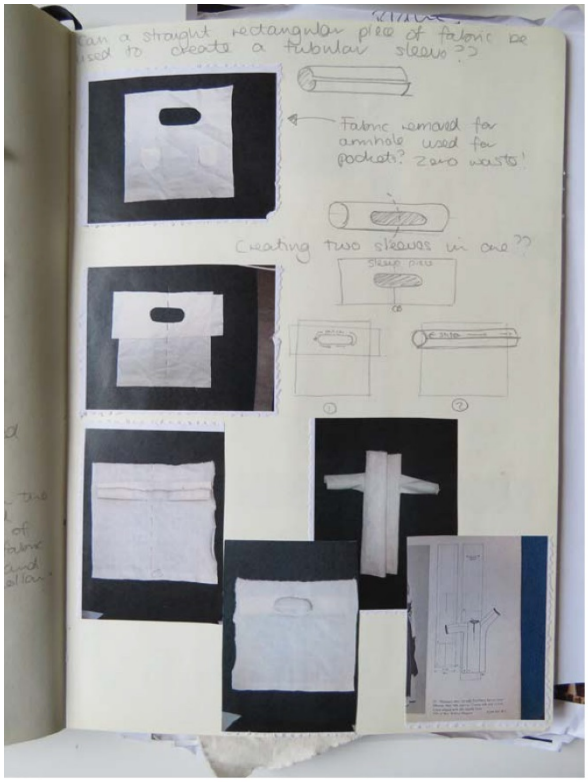

Returning to the concept of the cross and creating the body in one whole piece, is it possible to translate the bias sleeve concept (opposite) into a one piece body pattern??
Interestingly, once constructed the sleeves that hang on an angle form a diamond which is the T shape.
The sleeve seam twists around the sleeve.
I cut the body shape on the bias so the seams on the sleeve are initially on the straight of grain


Back
Front
On the body the sleeve seams can't be seen from the front and are visible from the back As there is little difference between the front and back, possibly the front could be the back and vice versa Would be interesting to see, once on the body which would be more suitable as the back and the front
Is it best to have the sleeve seam to the back as this looks like it works with the slight curve of the elbow?

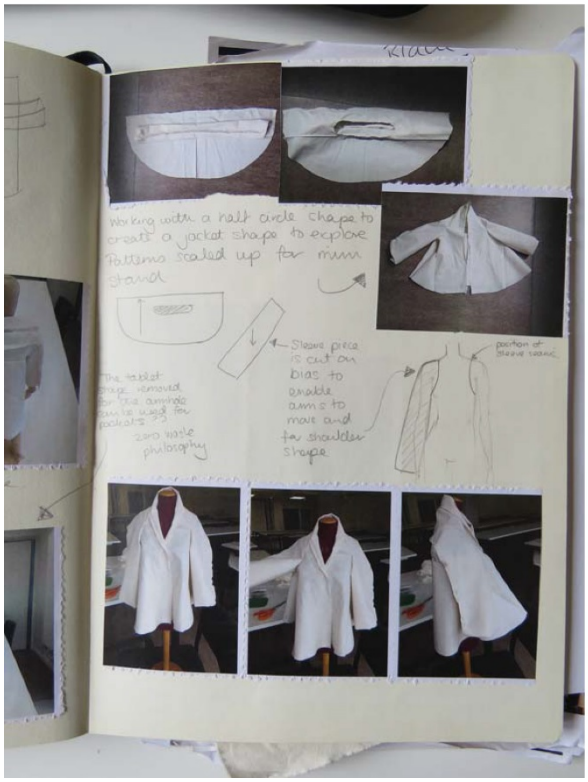

Returning to the
neck -
CB
Fold line
Neck width
Sleeve
CF

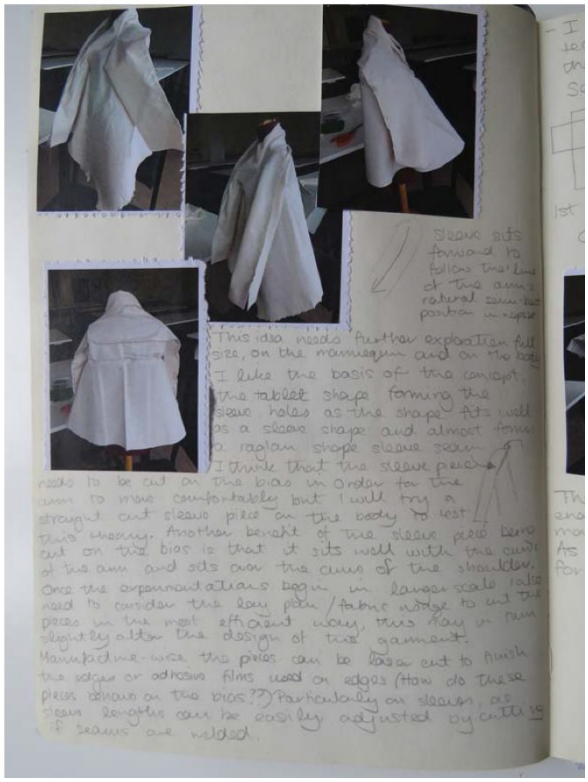

Returning to the knitted one pattern piece dress
Fold for collar
Stitch line
Front
CB
Side
Back

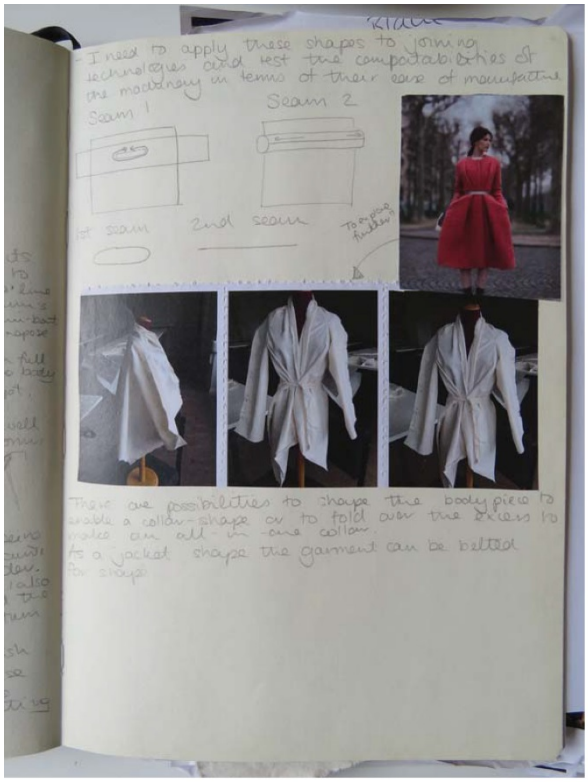

In the one piece dress the sleeve section where the arms are put through is formed by a tablet-shaped hole
I am interested in this concept and how this could be explored.
The piece can be pinched around the armhole point
This version as with the one piece dress fall against the sleeve of the neck so excess fabric can be folded over and used to create a collar

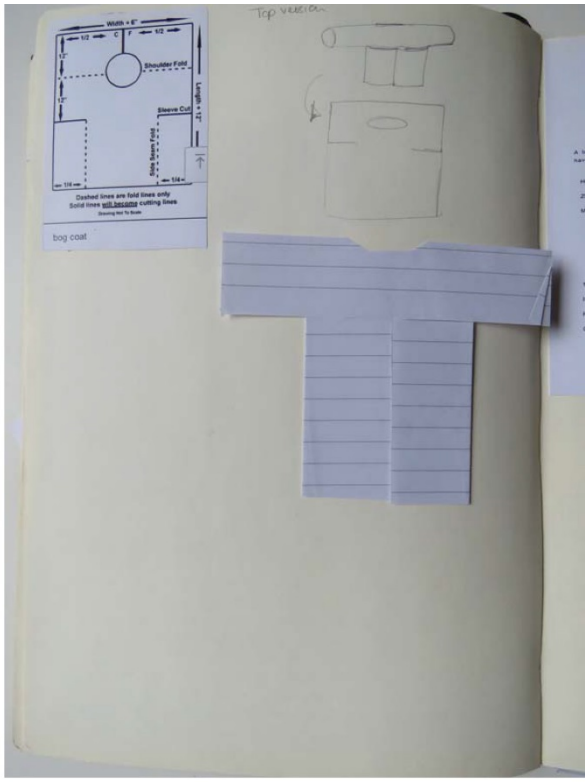

Can a straight rectangular piece of fabric be used to create a tubular sleeve??
Fabric removed for armhole used for pockets? zero waste!
Creating two sleeves in one??

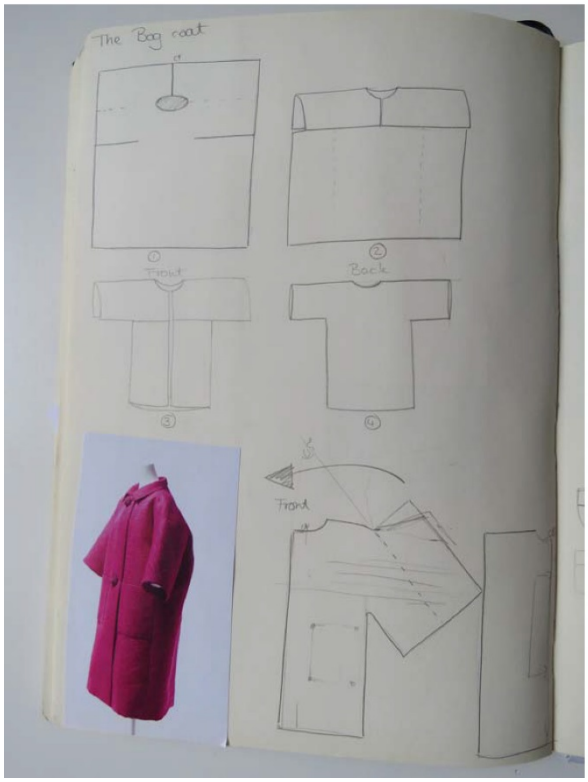

off the body
on the mini mannequin
Front
Back

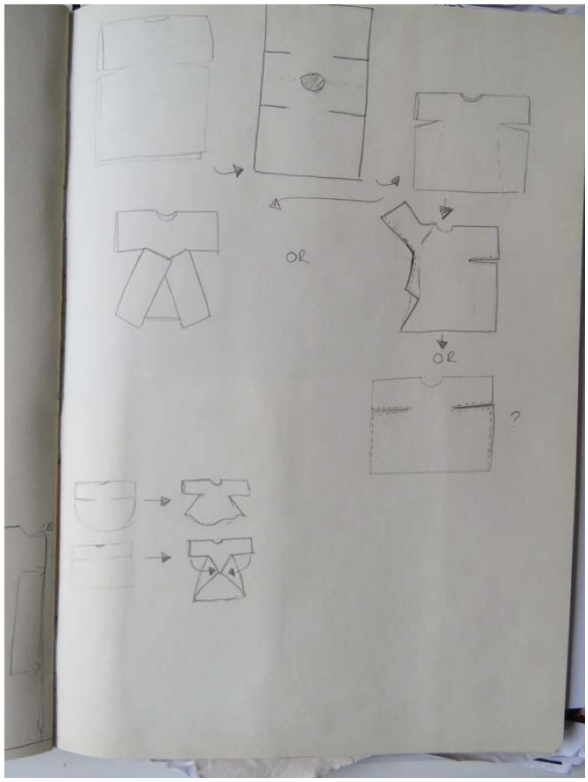

Working with a half circle shape to create a jacket shape to explore Patterns scaled up for mini stand
Sleeve piece is cut on bias to enable arms to move and for shoulder shape
position of sleeve seams
zero waste philosophy


Sleeve sits forward to follow the line of the arms natural seam line position in space
This idea needs further exploration full size, on the mannequin and on the body. I like the basis of the concept, the tablet shape forming the sleeve holes as the shape fits well as a sleeve shape and almost forms a raglan shape sleeve seam.
I think that the sleeve piece needs to be cut on the bias in order for the arm to move comfortably but I will try a straight cut sleeve piece on the body to test this theory. Another benefit of the sleeve piece being cut on the bias is that it sits well with the curve of the arm and sits over the curve of the shoulder.
Once the experimentations begin in larger scale I also need to consider the lay plan / fabric usage to cut the pieces in the most efficient way, this may mean slightly altering the design of the garment.
Manufacture-wise the pieces can be laser cut to finish the edges or adhesive films used on edges (how do these pieces adhere on the bias??) Particularly on sleeves, as sleeve lengths can be easily adjusted by cutting off if seams are welded.


I need to apply these shapes to joining techniques and test the compatabilities of the machinery in terms of their ease of manufacture
Seam 1
Seam 2
1st seam
2nd seam
To be top finished
There are possibilities to shape the body piece to enable a collar-shape or to fold over the dress to make an all-in-one collar.
As a jacket shape the garment can be belted for shape


Top version
Width + 6"
1/2
C
Shoulder Fold
Length + 1"
Sleeve Cuff
Side Seam Fold
1/4"
Dashed lines are fold lines only
Solid lines will become cutting lines
bag coat

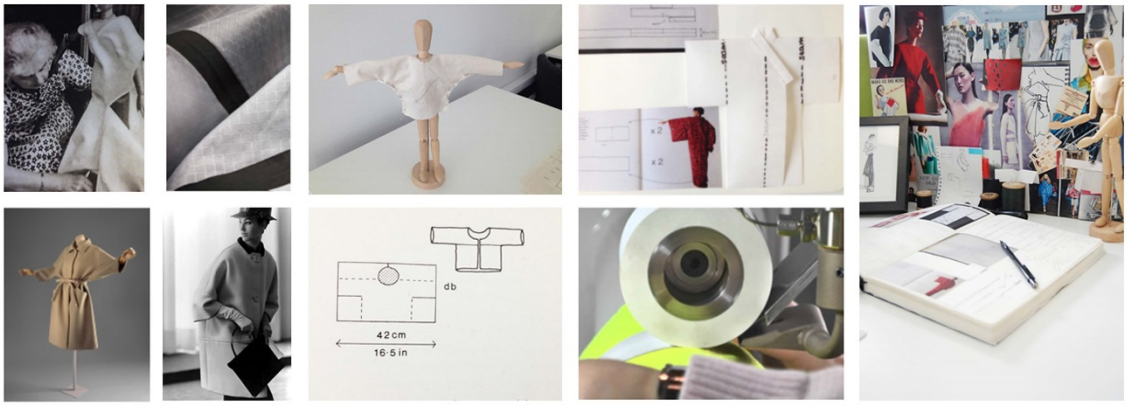

The Bag coat
1
Front
2
Back
3
4
Front


OR
OR
?

.

Appendix 8 - Project summary

Patternmaking
for new fabric joining technologies



Elena Etheridge

Concept

Fabric joining technologies of bonding and welding can bring a new aesthetic to clothing. They benefit the manufacturing process, as many construction processes are simpler and some machine operations are fewer than with traditional sewing.

If construction methods are different, do we need to adapt how patterns are made and clothes are designed to suit these new joining technologies?

Process

Various methods of bonding and welding fabric seams and finishes were explored through sampling.

Looking back at clothing history brought focus on garments constructed from basic geometric shapes such as the Japanese kimono. Examining these loose unstructured shapes, made to fit the body with ties and wraps inspired the silhouettes and fit of the garments.

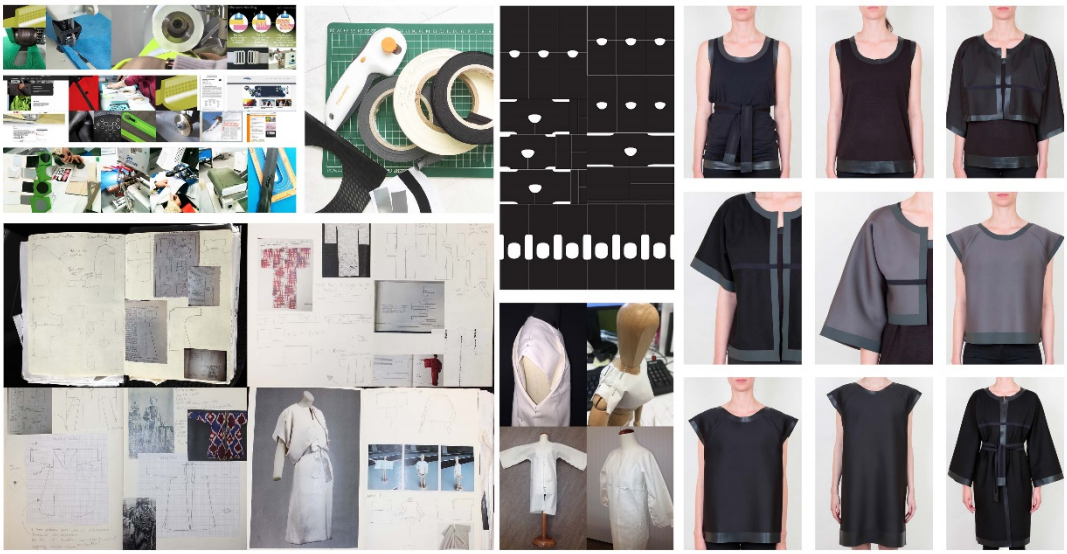
The process of creative patternmaking is designing and developing garments with cloth in 3-dimensions. This is unlike the traditional fashion design process of sketching an idea then making a plan for construction and manufacture through pattern cutting.

Working in this way meant that the pattern and design ideas could be adapted to suit the construction methods of the joining technologies.

The shapes of the patterns were carefully considered to work with the joining methods and waste as little cloth as possible when the pieces were cut from the cloth.

Results

The resulting garments bring these concepts together and offer new possibilities for using joining technologies in fashion.



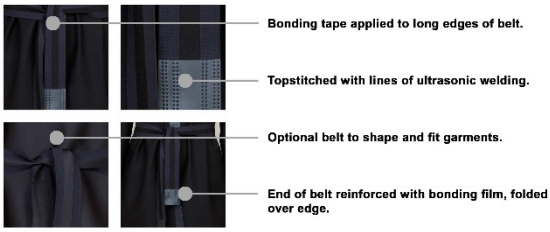
Construction

Fabric tape bonded to reverse of fabric to form dart.

Dart shapes cloth from neck edge to underarm.

No visible construction of dart from right side of fabric.

End of dart is folded into underarm and forms edge of sleeve.

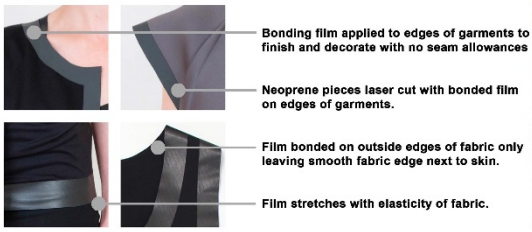


Bonding tape applied to long edges of belt.

Topstitched with lines of ultrasonic welding.

Optional belt to shape and fit garments.

End of belt reinforced with bonding film, folded over edge.

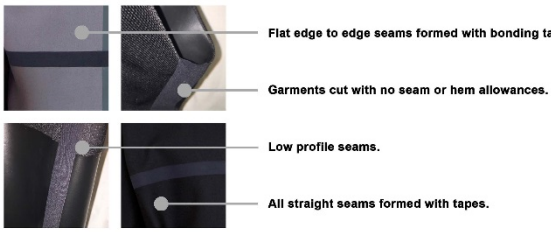


Bonding film applied to edges of garments to finish and decorate with no seam allowances

Neoprene pieces laser cut with bonded film on edges of garments.

Film bonded on outside edges of fabric only leaving smooth fabric edge next to skin.

Film stretches with elasticity of fabric.



Flat edge to edge seams formed with bonding tape.

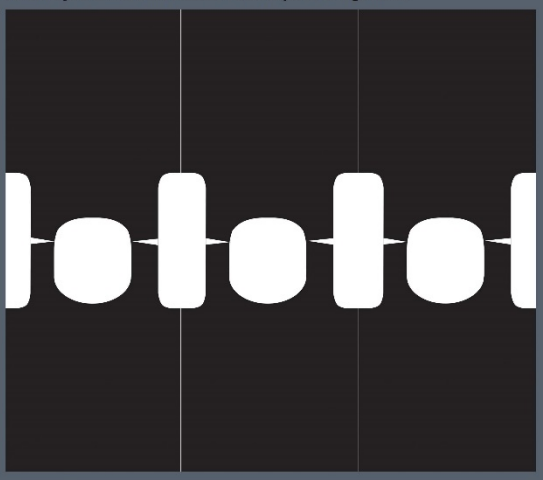
Garments cut with no seam or hem allowances.

Low profile seams.

All straight seams formed with tapes.

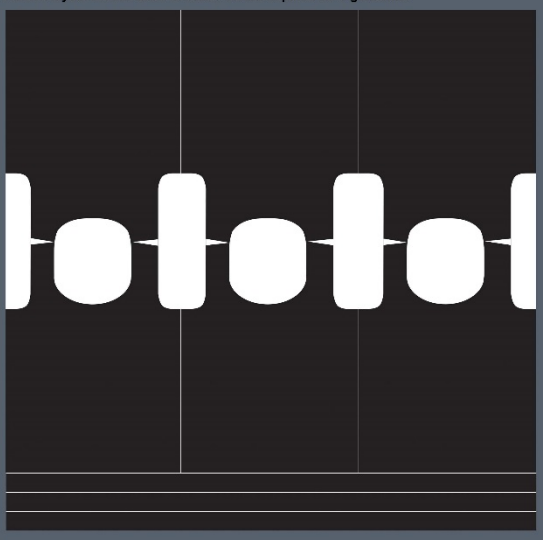
Vest

Pattern layout across width of cloth: 130cm required for 3 garments.



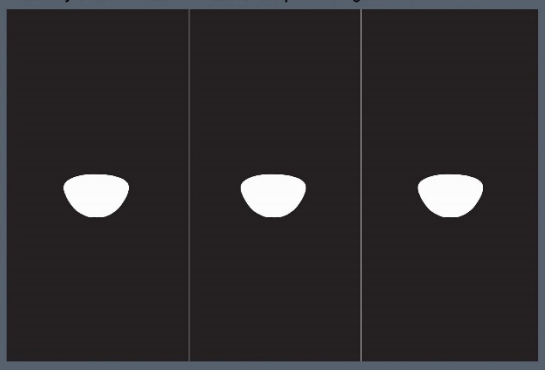
Belted vest

Pattern layout across width of cloth: 148cm required for 3 garments.



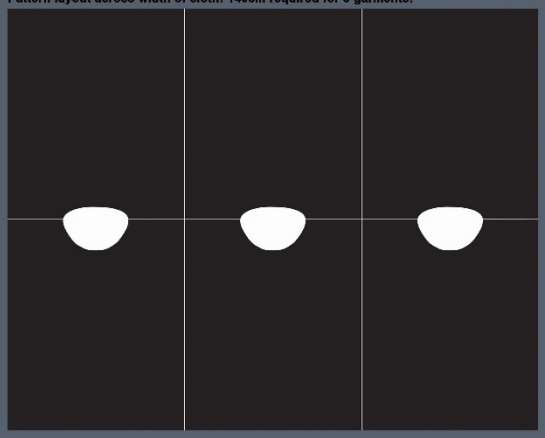
Short top

Pattern layout across width of cloth: 112cm required for 3 garments.



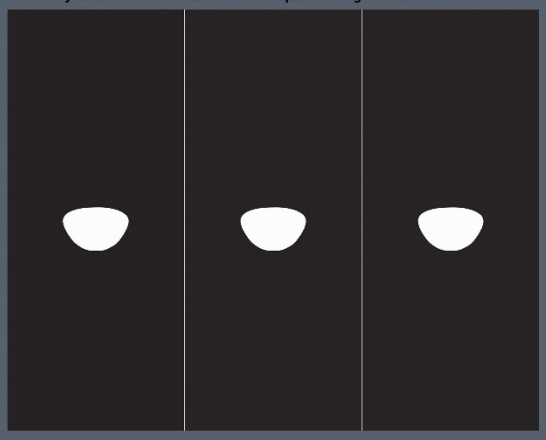
Mid length top

Pattern layout across width of cloth: 140cm required for 3 garments.



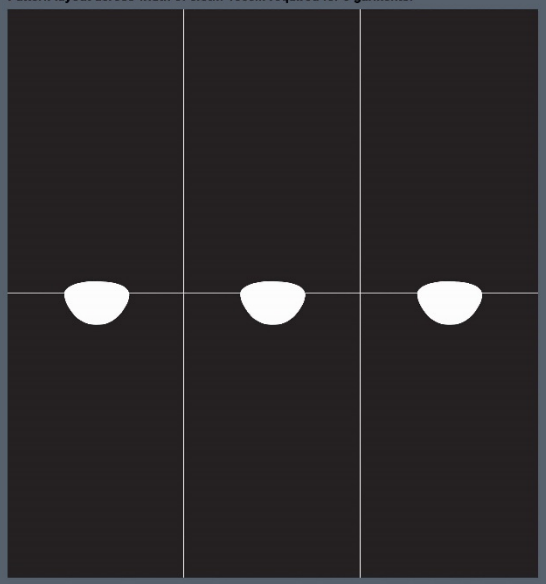
Unstructured top

Pattern layout across width of cloth: 140cm required for 3 garments .



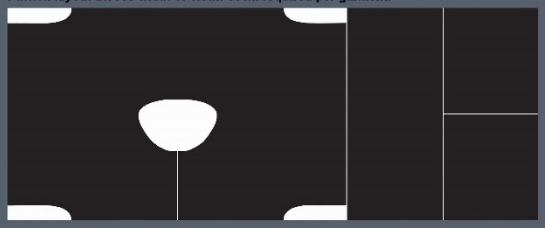
Dress

Pattern layout across width of cloth: 186cm required for 3 garments.



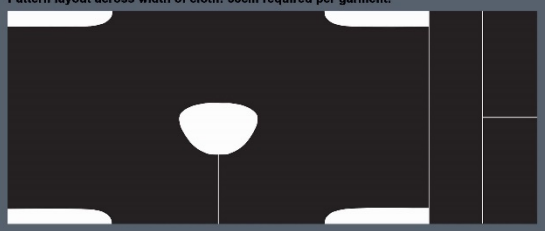
Cardigan

Pattern layout across width of cloth: 58cm required per garment.



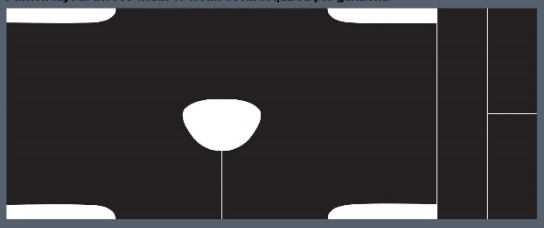
Shrug

Pattern layout across width of cloth: 58cm required per garment.



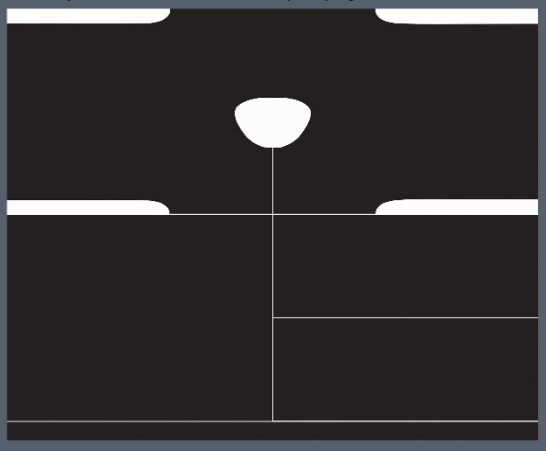
Cropped Jacket

Pattern layout across width of cloth: 58cm required per garment.



Coat

Pattern layout across width of cloth: 122cm required per garment.



Appendix 9 - Industry feedback

Biographies of experts taken from online profiles

Expert 1 David Telfer (DT)

David is a ready to wear menswear designer specialising in sustainable pattern cutting techniques such as Minimal Seam Construction and Zero Waste. Having started using these techniques studying at the University of Brighton, his work with zero waste has been shown in exhibitions worldwide. He has collaborated on academic research alongside working as a practising designer.

David worked for COS for 6 years designing for the menswear classic and leisure departments and currently works for Sunspel as a Senior designer across men's women's and accessories.

Expert 2 Professor Julian Roberts (JR)

Julian Roberts is a fashion designer and filmmaker, who has shown 13 collections at London Fashion Week. Julian studied womenswear in Newcastle upon Tyne, and completed his menswear MA at the Royal College of Art, London. He was awarded a Professorship and set up the new fashion school at the University of Hertfordshire in the UK in 2004, and now lectures in MA Mixed Media Textiles at the Royal College of Art in London. Julian has lead creative cutting workshops at over 20 universities in the UK, and in over 17 countries worldwide. Julian Roberts is the inventor of a garment pattern cutting method called 'subtraction cutting', which he demonstrates live in front of large audiences in America and the UK, teaching people of all ages and levels of expertise how to construct creative clothing.

Expert 3 Lacey Johnson (LJ)

Lacey Johnson is the global brand manager for Bemis, a 100-year-old adhesives & specialty films company trusted by the world's great technical, performance, luxury & lifestyle brands including Nike & Under Armour .The company's adhesive films and seam tapes can be used to replace traditional cut and sew methods in the production of sports garments, soft goods and consumer electronics.

Expert 4 Rob Warner (RW)

Rob Warner is the co-founder of Spark, design consultants for luxury fashion and sportswear brands. He is the designer of World Cup and Olympic gold medal winning collections. Rob created the first fully welded football kit in 2006, for Italy's World Cup team. He is internationally renowned for his work within performance sportswear and innovation and has held executive level creative positions at prominent brands in the UK, Germany, the Netherlands and Canada including head designer at Umbro and VP for Men's Design at Lululemon.

Hi,
My name is Elena Etheridge, I work at Manchester Metropolitan University and I am studying for an MA by research.

My background is as a womenswear designer and pattern maker. I've been doing a practical research project and developing a range of garments that are made entirely with bonding and welding methods of construction. The title of the project is 'Patternmaking for new fabric joining technologies'.

I need some feedback and comments on my work for the conclusions of my thesis. Is this something that you would be happy to do?

I have attached some images and information about the project, if you could let me know your feedback on the attached questions and fill in the consent form, that would be greatly appreciated.
I have also put some other images from the project on:

twitter: https://twitter.com/ElenaEtheridge?lang=en-gb
Instagram: https://www.instagram.com/elenaetheridge/?hl=en
Thank you so much for your time, I looking forward to hearing from you.

Elena

The garments: *The aim of the research is to develop and adapt approaches to pattern making to consider how new fabric joining technologies can be incorporated into contemporary fashion. My main objective was to achieve this by developing and adapting a design approach that considered the technical requirements of the construction method. Considering this as the project brief, what would be your comments on how successfully this was achieved through the resulting garments?*

1 DT I do really like your work, and the cocooning /rounded silhouette both the technique and your pattern cutting causes. I do think as part of your project you could think of how a standard high street designer that doesn't have your knowledge of these technique could learn from your work and understand the possibilities of using this technology.

2 JR I particularly like the way you have used technology both to practical effect, in creating flat seams/neck/armhole/hem facings which don't fray or require facings or stitching; and also the aesthetic effect, as the garments all look contemporary, clean and sharp.

The most important consideration in prototyping and developing new ethically driven garment products which waste less material, or are constructed with ease of manufacture in mind, is that they look really good and are desirable.

Without these important aesthetic considerations, there is little need or audience for the product, and it will not deliver upon its sustainable aspirations.

3 LJ Considering the positioning of your concept, it may be interesting to look at it from the lens of a new method of make that infuses technology into garments versus the traditional cut and sew. In addition, the benefits go far beyond aesthetic into performance attributes and benefits that can't be achieve through sewing.

4 RW The wearable, seasonless collection would appeal to a wide range of consumers. Whilst not being targeted toward the athleisure sector - itself predicted to be an $87bn market within the next 5 years - it captures the insight behind that movement, notably the desire to wear clothes and outfits in an array of environments and situations. The upshot of a modern life spent in constant transition.

Viability of construction methods: *Some of my findings from tests with the joining technologies was that they allowed for construction techniques not possible with traditional cut and sew methods. Do you think that using these new methods of construction can also bring new possibilities to creative pattern and garment design?*

1 DT I think a project like yours is great to do to push the technology and thoughts behind it, but I do think it's good to then think how is this going to be relevant to the day to day industry, again how can a designer learn from this and apply it to their own work?

2 JR I think that the viability of these construction methods will be determined through user testing: wearing in real life situations over measured periods of time, and laundry/dry clean testing. I think the construction methods stand a good chance of being viable, but theory should not lead practice.

Considerations should also be made that eventual deterioration might yield new aesthetic values, like worn-in denim, bobbly sweaters, holy knees, or certain elements of wear-and-tear which become aesthetically valued.

Testing your garments to destruction might be worthwhile in answering this question.

3 LJ The ability to infuse technology and not have to think about where stitch lines goes opens up an entire new world of pattern making. If you don't have to think of a stitch line, what could you design? How would your design process and structure change?

4 RW The collection is highly commercial, aesthetically directional yet familiar, and brings advanced manufacturing techniques into a new arena - simplifying the process and benefitting the environment along the way.

(PC) Working method: *As I was working with a technology that was new to me and required new thinking around the construction of the garments, I found it more appropriate to develop design ideas three dimensionally to be sure that they were technically possible. What have you found to be the advantages and disadvantages of working in this way, designing garments through patterns as opposed to creating a sketch to realise through pattern cutting?*

1 DT My focus on pattern cutting started as a way of making clothes quicker, it then led into zero waste just because it's a more understandable 'sustainable' technique. I struggle with both of these techniques for use within the real industry mainly because such a massive process has to go into creating each garment and at some point the actual visual design will be compromised by using these techniques. This is why I find it hard to envisage the techniques that I teach being used in the industry, my day job as a designer is sometimes informed by what I have learnt through the techniques but never constrained by them.

2 JR Personally, for myself I work in 3D manipulating the material and construction process to create the garment design. Along the way geometric risks are taken, and new discoveries made which could not have been foreseen had the design drawing come first and been faithfully adhered to. The advantages of designing in patterns in 3D is that the maker is in direct (hand) contact with the material, and able to better learn from and understand it's tactile properties. This allows the designer to foresee and overcome manufacture problems which may later have been discovered during sampling/sealing.

So long as the prototype is photographed or sketched after it is made, to aid visualisation during manufacture, then there is no real disadvantage to designing in patterns. I do however think that design drawing needs to adjust to be far more technical and explicit of how the garment is constructed and made, rather than simplifying viewpoints into back/front views only. A garment is always three dimensional and can be turned 360°, flipped upside down, turned inside out with an inside viewpoint as well as an outside, and design drawing/illustration needs to evolve to express this must more expertly.

The only reason to draw or illustrate a garment is to help push and develop design ideas beyond the obvious, and to explain the proposed garments construction in detail, otherwise photographs and toile prototypes are just as useful.

(JT) Working method: *I have experience designing and making for traditional cut and sew methods. Through this project I have found that joining technologies require a completely new way of thinking and can actually offer many advantages over cut and sew methods in that some construction methods can be simplified. What have you found to be the advantages and disadvantages of working with joining technologies as a method of garment manufacture?*

3 LJ I would be careful in terms of manufacturing efficiencies and the simplicity to execute. Our belief at Bemis is that in fact many of the applications are more efficient and require less material to manufacture; however, you have to develop skilled-labor in order to achieve this. Until factories have invested in their labor, efficiencies may not be seen and costs/time to execute may go up. This is one of the biggest barriers to entry that we face on a day-to-day basis.

4 RW This work shows a considered understanding of the current needs of the fashion industry, notably the combination of a thirst for innovation and a yearning for sustainability. Bonding in and of itself can be considered an answer to this, but often brands will shy away from this method of manufacturing, basing their decision largely on price. The project answers this conundrum by combining the timeless style of traditional Japanese clothing with an approach to pattern making which simplifies the production process whilst simultaneously delivering a dramatic reduction in waste from the yield of the fabric.

Appendix 10 - Paper presentation from The Second International Conference for Creative Pattern Cutting, 25th February 2016.

Elena Etheridge, Manchester Metropolitan University

Pattern making for new fabric joining technologies.

Abstract

Traditional garments such as the Japanese kimono are simple in construction and use few, geometric pattern pieces. Fit is achieved through wrapping, draping and tying the garment on the body. Expanding on these principles and through exploration of this approach, design ideas can be generated three-dimensionally.
Alternative fabric joining methods such as bonding and welding have developed over several decades and more recently have mainly been used in sports clothing, performance wear and lingerie. These technologies have unexploited potential in fashion garments and can benefit the manufacturing process by reducing machine operations and seam components.
This paper documents a design practice-based research project. Approaches to creative pattern making are explored, developed and adapted to consider new fabric joining technologies in contemporary fashion.
This methodology incorporates issues of sustainability into the design and manufacturing processes and the use of innovative pattern cutting approaches create new design possibilities.

1 Pattern making for new fabric joining technologies
This presentation documents the work I've been doing for an Ma by Research through Manchester Metropolitan University which is still ongoing. So I'm going to talk about the practice based research project that I've undertaken which is entitled: pattern making for new fabric joining technologies.

Background & Motivations

2I'm going to start by briefly talking about my background and the motivations behind my work.
I've made clothes since I was a young teenager so I've always had an interest in construction and when I studied fashion design at university I developed a real interest in pattern cutting,
I discovered Vionnet, her work, the way she approached patterns and her ways of developing ideas. I found it much easier to develop my design ideas if I worked three dimensionally, so inspired by Vionnet I started draping in miniature, applied these ideas to garments and then developed them into final pieces.
I think the most important thing that I learnt from this was the process, not just using pattern cutting as a problem solving exercise, to realise a design sketch, but using patterns and three dimensions to develop ideas.
At the same time, another influence on my work, which links in some ways with Vionnet was the Japanese kimono. I became interested in the silhouette, the relationship between its shape and the way its worn on the body and the simplicity of the pattern and cut.
I've worked making and fitting bespoke clothes over a long period in the past and over the time I've made clothes, I have developed an understanding of the importance of cut, fit and the body's relationship with a garment.
I've also taught for about 10 years mostly pattern cutting and construction and I took these interests through into my teaching, so I was always encouraging students to push their silhouette ideas, think about cut and to use 3D development throughout the processes of design and making.
When I started working here I was amazed at the machinery that we have and this made me think about how I could use it in my own work.

Research project

How can a design practice-based enquiry be used to develop and adapt approaches to pattern making that are needed when considering new joining technologies for contemporary fashion?

3 My research look at how a design practice based enquiry can be used to develop approaches to pattern cutting for joining technologies., looking at whether joining technologies require a different type of cutting for their use

Aims

1. **To overview previous and current pattern making approaches to inform a design methodology.**
2. **To establish, through practice a more considered design framework which considers new and emerging technologies.**
3. **To apply findings to a fashion as opposed to a technical context.**
4. **To exhibit and disseminate findings.**

4The Aims

Methodology

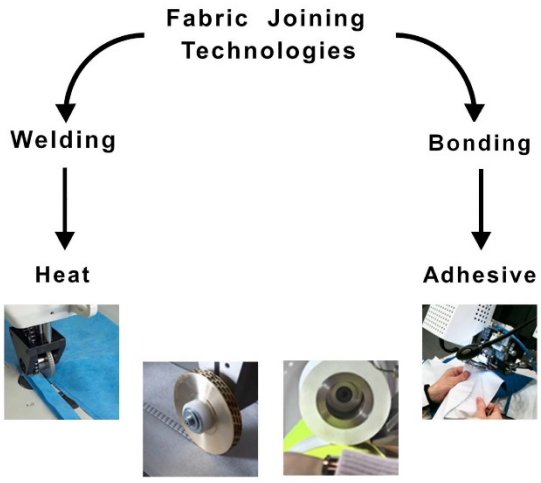
Iterative design process

Reflective practice

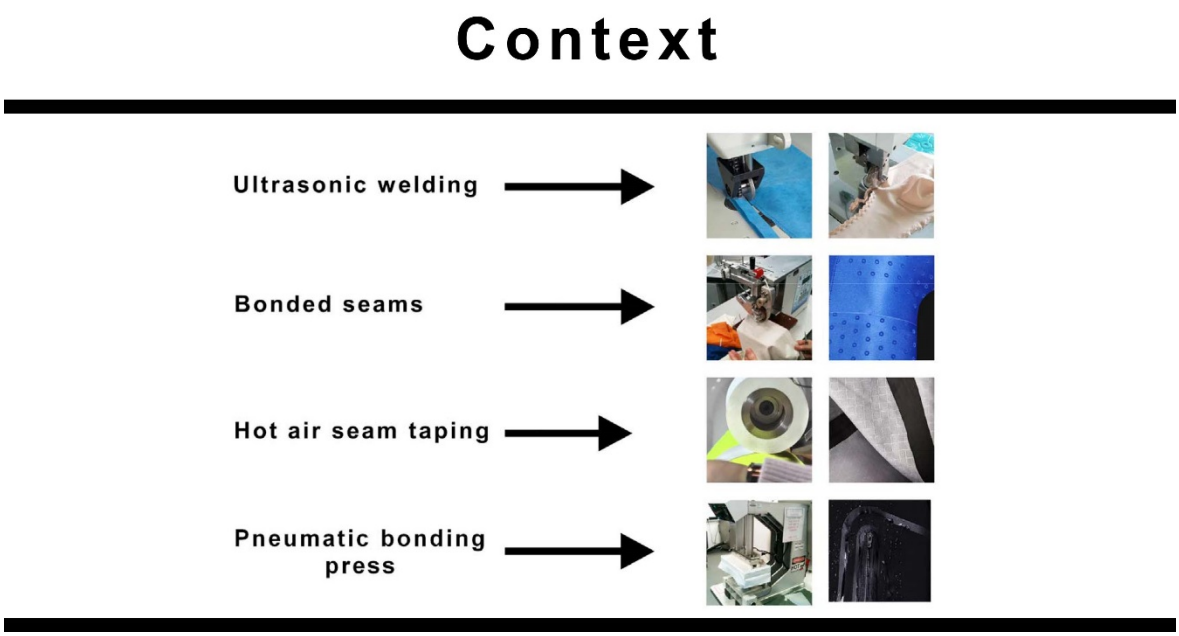
Agile methodology

5Practice is central to the research, I'm using design as a mode of enquiry, taking an iterative approach.
An exploration of the joining technologies through practice, informs further pattern development and design ideas, and the iterative process allows technical and design considerations.
A journal and sketchbooks are used to record and reflect on the work and to allow development of ideas.
Garments are produced to illustrate the findings and to enable further critical reflection

Context



6So what are joining technologies?
Another means of joining fabric other than stitch,
so welding is a process where heat, sometimes combined with pressure are used to join a fabric which is made either predominantly or entirely from a synthetic yarn, which is heated causes the fibres to melt together and form a join in the fabric,
Bonding- is a process where an adhesive is used, heat is applied and once cooled the fabric surfaces are bonded together

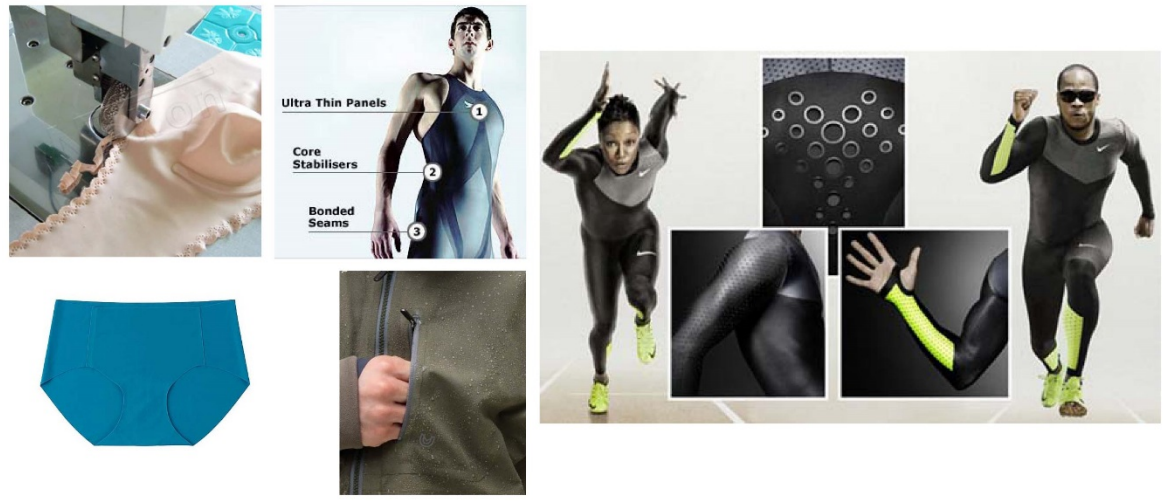


7Some examples are ultrasonic welding, the sound waves affect the synthetic fibres and form the join
bonded seams where adhesive is applied then the seam is bonded together to form the join,
Hot air taping - where seams are taped to seal them using hot air to bond them to the fabric
Heat press where the heat and pressure ensure the bond.
Some of the technology uses a combination of these means to join the fabric, heat. pressure hot air and some of the machines work hand in hand with each other.

Context

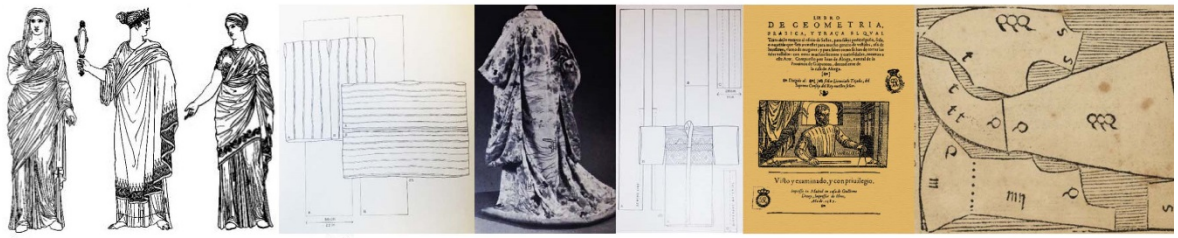
8In clothing, joining is mostly used in the lingerie market and sports/performance wear markets.
The main benefits are low profile seams, some of the joining processes are multifunction so they perform several actions in one machine operation and they can be water or windproof.

Context



9In lingerie, the benefits are that it can create low profile seams so its suitable for bras and briefs, this example you can see it's an ultrasonic seam where its cutting, sealing and decorating. Then these are briefs which are laser cut in one piece then with two bonded seams at the front.
Low profile seams are also more aerodynamic, so they've been used in performance wear, this is the speedo Lazer suit which Michael Phelps wore in the Olympics, so the flatter seams helped him to go faster in the water, these full body suits were so effective, 98% of the medals won at the Beijing Olympics were from swimmers wearing the suit and they went on to be banned in competitions.
Nike pro turbo speed suit, this is a version of an earlier speed suit created for sprinters, this one was launched for London 2012 Olympics and the bonding is used on the some of the leg seams and seams on the arms, to be more aerodynamic, but also because its light weight, Its also got bonding film on the back with holes lasered for ventilation and around the neck. This is what nike calls zero distraction, so the bonding film is applied to the outside to seal the edge so there's no stitching next to the skin which could cause chafing They also did a range of track and field kits similar in design and featuring the bonded seams and edges.
Another way you'll see bonding used is for waterproofing, so waterproof jackets will have sewn seams on a waterproof fabric, but they're taped to seal up the stitch holes.
Waterproofed Zips on pockets can be bonded onto waterproof jackets, again to stop the water permeating through the fabric.
Another advantage, can be to the manufacturing process so a joined seam or a hem may take fewer machine operations than a traditional sewn seam or use less seam allowance.

Context



10 Whilst I was learning about the joining technologies available, I started to look into the history of patterns, and how pattern cutting emerged throughout the history of clothing,
So, I looked at these in terms of draped garments, wider cloth, draped on the body, Cut garments, where garments were formed with narrower widths of cloths stitched together to form a garment as with the Japanese kimono and

then the emergence of tailoring where the cloth starts to be cut and sculpted to follow the form of the body.

Context

11Then I went to look at more contemporary cutting examples, returning to my interest in Vionnet, Clare Mcardell and what interested me was how she worked within the constraints of mass manufacturing, Balenciaga and the purity of cut, his silhouettes and then I started to look at zero waste pattern cutting and the current interests around this as a practice. Which brought me back to the kimono which is an example of a zero waste garment and another thing that interested me about this was that the garment, its form and its construction was dictated by the available technology, which was this width of the loom, so due to this the garment is constructed from the narrow widths of cloth.
So I began to bring the two strands of my research together, the joining technologies and the patterns. Looking at how simplifying a pattern to basic geometric forms to suit the joining methods and exploiting the advantages that joining technologies can bring to the manufacturing process.

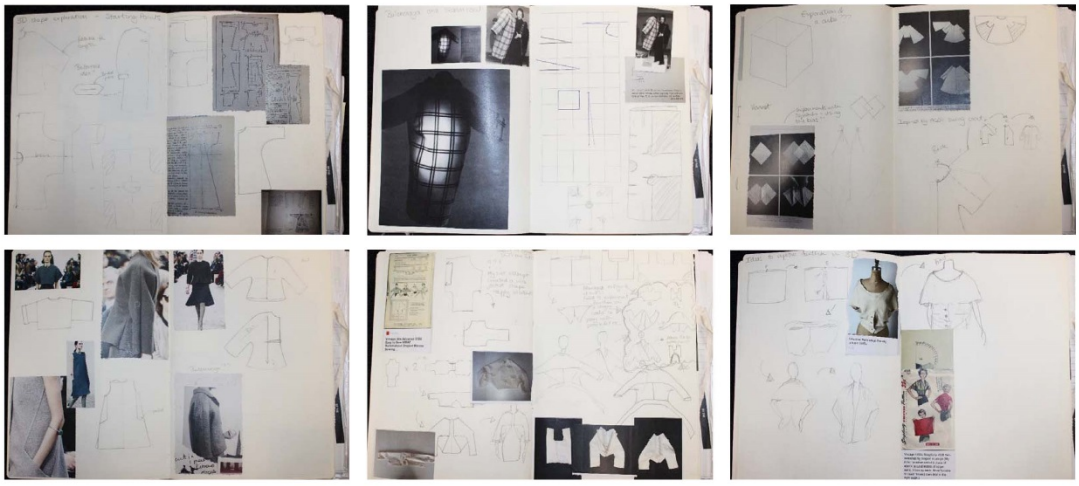
Practice

12I began to try all the different machines, learn how they work, test out what work well what doesn't. I tried to be more experimental rather than just follow the guidelines for various existing seams,
It was interesting because I'm so familiar with sewing that in a lot of ways I had to forget what I knew but at the same time there were things that were very similar, but also things that could be done that aren't possible with sewing

Practice

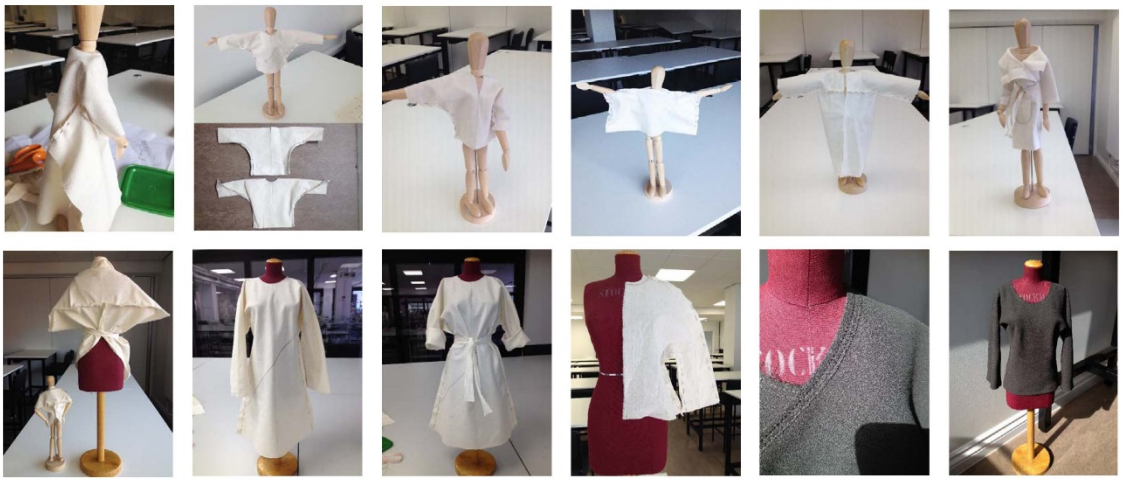
13At the same time as this, I started to look at historical garments and pick out examples of cut garments where the patterns were formed from simple geometric pattern pieces. And I began to visually analyse the garment and the pattern pieces, draw them to analyse where the seams are learn from how the garment shapes are formed.

Practice



14Without thinking about the joining methods, I started to pick out examples of interesting cutting to further explore, so I started working in sketchbooks, analysing the patterns, to allow me to start thinking about creative cutting and at this point I wanted to be more experimental so these were just really a starting point for further development.

Practice



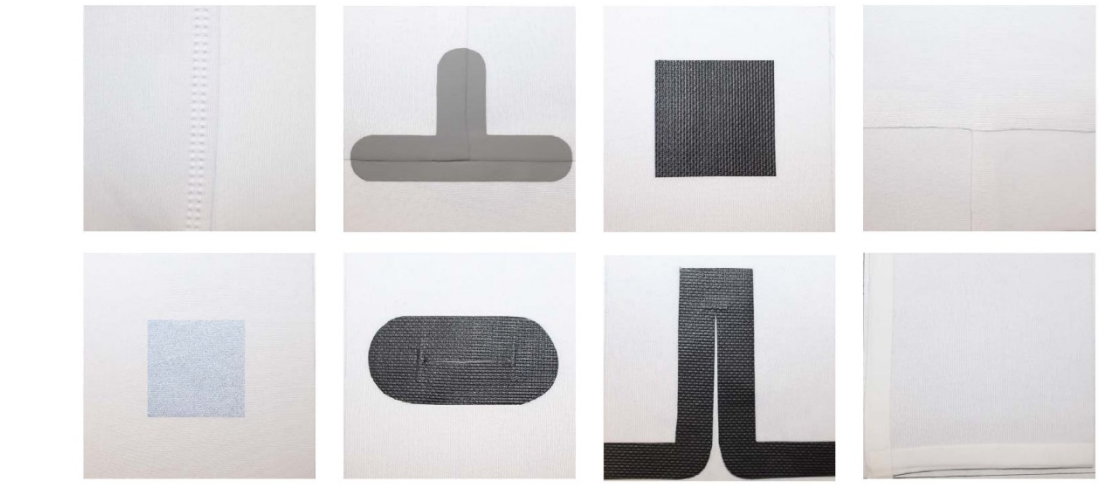
15Again, without considering the effect that the joining would have on the patterns, as I was still learning the machinery and the processes I started to develop my ideas on a mini mannequin, The rationale for this was 1 because it's a working method I've used before to develop my ideas but for this project it worked to simplify the patterns to fewer components. 2 If I'm taking advantage of joining technologies decreasing machine operations then it would make sense to also design the patterns with fewer seams. So, I worked on very small mini artists mannequins and

a half scale stand using the ideas I had started to look at in my sketchbooks. I'd started to research practice based research and through this and by reflecting on my work and processes I came to appreciate the tacit knowledge involved in pattern cutting, so although I was developing ideas on small mannequins. I was still taking a very considered approach, as I was thinking about how they would scale up, what they would ,look like what the fit would be, so although I wasn't thinking about JT it was still a very conscious process in other ways

Practice

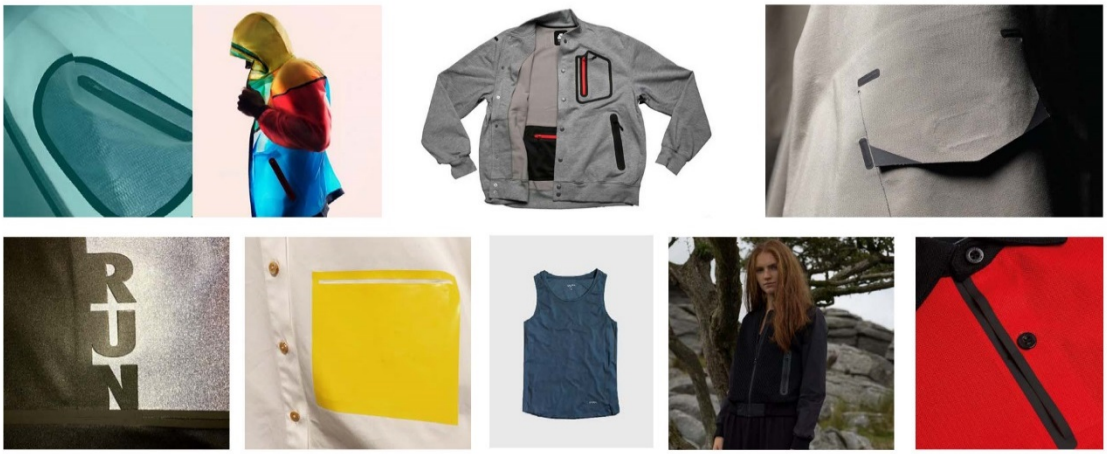
16So, after my joining sampling I came out with some not very attractive looking samples in different colours and fabrics, which I wasn't really interested in recording anywhere.
But then I came to value the process that I had been through of familiarising myself with the machines, work out the restrictions, the fabric types that worked, how they function, what they look like aesthetically .

Practice



17Led me on to produce final samples, considered the fabric suitability, I made a file with different samples and a record of the machines that I used and the processes.

Design development



18As I had started to explore shape through patterns and learn about all the various means of joining fabrics on the machines I began the design development stage. At this point aesthetics was becoming a factor and as time had gone on and through my interest in joining technologies I begun find examples of where sportswear companies had begun to use joining technologies in more innovative ways and more for the aesthetic qualities.

Design development

19Through learning the joining technologies and the file of samples that I had produced, I had created some rules about how they could be used, so I started to think through previous pattern and design ideas that I had developed in miniature and began to draw out ideas, Not finished designs by any means, just very rough sketches. Not about presenting the ideas but more about using drawing to think through design ideas and how the construction would work. Again, reflecting on my design processes and having the time to do this, allowed me to appreciate the value of drawing as a tool for design thinking.

Design development

20

Now I started to work on the stand but with the Joining technologies in mind so these are ideas , that I had worked out how the construction would work and I started to work these through.

Design development

21

Then I had been making samples of the joining technologies and almost by accident found out that if I formed a dart, which I hadn't really considered as I was only thinking about seams, then I could bond a strip of tape on the back to keep it in place which wouldn't be seen.

So then I started to work out this idea, which didn't work when I started to scale it up, but then I moved the shaping to the shoulder and as I developed it started to work. So, this is formed with one strip of fabric, half the width of the cloth, then the darts are folded round to the side to form the sleeves

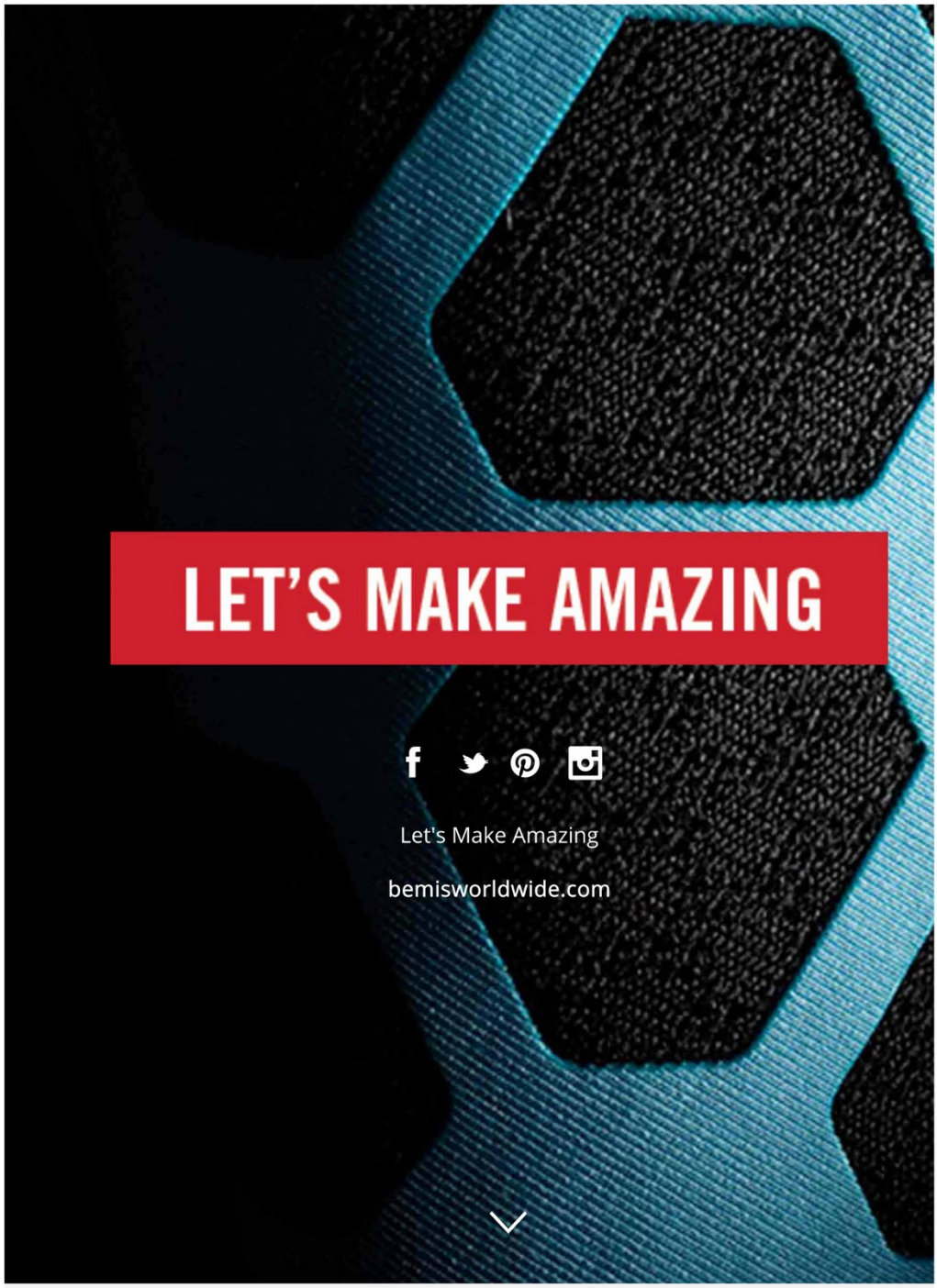
Design development

22
Started to scale up this idea into fabric, test the bonding and test the shape,Made a toile of the dress in full size, testing the bonding,
At this point, I had only done samples of the bonding, calico toiles for the shape and miniature garments so there were some things that were unknown, so this allowed me to learn lessons from this process before I go onto design and make more garments

Design development

23
Then I used a lighter fabric, a jersey, shortened the shape into a top. *In terms of fabric was* more successful than the dress.
Starting to develop this idea, I'm happy with how the fabric works with the bonding and the construction and I want to further develop some earlier ideas, a jacket, top shape with sleeves
The project is ongoing, so I've got more garments to develop using the same process so I'm going keep going.
Thank you

Appendix 11 - Bemis designer profile.




MAKE-DO AND MEND

Designer Profile: Elena Etheridge

We have the Twittersphere to thank for connecting us with designer Elena Etheridge. Across the pond in the UK, she is using Bemis products to explore the new possibilities of pattern making and garment construction.

For the last ten years, Etheridge has taught fashion design. Recently, however, roles have reversed. She is a student again, 18 months into a research degree at Manchester Metropolitan University. Her thesis' focus: whether or not, with the advent of new joining technologies, designers have to make things differently? For someone who has cut and sewn clothes for over twenty years, bonding represents a complete paradigm shift for Etheridge. One she decided was deserving of academic inquiry.

Generally speaking, one advantage of bonding is that it uses fewer components. The variables at play are time, pressure, and heat — very different from traditional construction. As Etheridge puts it, "I'm trying to forget what I know about garments and learn anew." To test her early ideas, she has started small. On a 30 centimeter mannequin. "Working in miniature simplifies things," she says. "Take any garment. In fashion there is a cycle. Someone will design it, someone will make a pattern, and someone else will manufacture. In order to learn a new technique, you have to flip that model a bit and do every step."

As part of her research, Etheridge is also designing clothes. She has drawn inspiration from historical garments like the kimono and apparel like Nike's elite track and field kit. Her garments are fashion-driven and experimental, namely because she is constantly weighting aesthetics with applicability.

Perhaps the most interesting imperative of her work is it's connection to a philosophical shift in education in the UK. For PhDs especially, there's a new focus on impact. Researchers are implored to think beyond their own personal interest to understand and meter the global resonance of their ideas. As Etheridge considers the technical process by which garments are made, she's keeping in mind ease of manufacturing and questions of sustainability. Could a fully bonded line, for example, be made in Britain? It's a call to action that is sweeping the fashion world. London College of Fashion has pledged a new commitment to teaching sustainability. So has Parsons in New York City.

Etheridge's work will finish up in February, so stay tuned for more from her material exploration.

September 15

#desgn
#Sewfree bonding
#apparel design
#fashion design
#garment construction

List of Illustrations and Tables

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